

PROJECT MANUAL
2013 CITY OF MASSILLON WWTP IMPROVEMENTS PROJECT

CONTRACT NO. 2 – GENERAL CONSTRUCTION

CITY OF MASSILLON, OHIO



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SEPTEMBER 23, 2015

CTI / O'BRIEN & GERE JOINT VENTURE
220 MARKET AVENUE SOUTH
SUITE 750
CANTON, OH 47702

Project Manual

2013 CITY OF MASSILLON WWTP IMPROVEMENTS PROJECT

Contract No. 2 – General Construction

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City of Massillon
Ohio

September 23, 2015



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09/23/2015

CTI / O’Brien & Gere JV

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Legal Notice

Sealed bids will be received at the Office of the Director of Public Safety and Service addressed to The City of Massillon, Attn: Joel Smith, 151 Lincoln Way East, Massillon OH 44646 until 2:00 p.m., local time, November 6, 2015, when they will be publicly opened and read, for all labor, material and services necessary to construct the project known as *2013 WWTP Improvements Project, Contract No. 2 - General Construction* all in accordance with the Contract Documents.

The WWTP Improvements Project increases the rated capacity to 17-MGD and completes various modifications including BNR upgrade. Primary Effluent Pump Station (PEPS) pumps and Biological Treatment Integrated Fixed-Film Activated Sludge (IFAS) equipment were pre-purchased under separate contracts (1a, 1b). Contract 2 – General Construction – includes, but is not limited to: Fine Screens and building, Odor Control system, PEPS structure, Anaerobic/Anoxic tankage and IFAS retrofit, Tertiary Filtration replacement, Pre-Thickeners retrofit, Boiler Room, chemical feed, inter-unit piping, and ancillary systems (HVAC/Plumbing, Instrumentation & Control, Electrical).

Contract Documents must be obtained from the following website: <http://bid.obg.com>. Interested parties are required to register on the website for the ability to view and/or acquire the Bidding Documents for the Project. It is the responsibility of any person or organization interested in a hard copy of the Bidding Documents to pay all costs associated with printing. Contact the Engineer, CTI - O'Brien & Gere JV, 220 Market Ave. South, Suite 750, Canton, OH 44702, (301) 731-1130 between the hours of 8:00 a.m. and 5:00 p.m., Monday through Friday, with any questions pertaining to access and use of the website.

All bids must be accompanied by a Bid Guaranty as described in the Instructions to Bidders. This is a Federal Davis-Bacon prevailing wage rate project. The project also includes Disadvantaged Business Enterprise goals as set forth in the Contract Documents. The project is also subject to the U.S. EPA policy of encouraging the participation of small business in rural areas. Recipient shall not entertain the use of businesses that are listed on the "Excluded Parties List System" at www.epls.gov in accordance with 2 CFR Part 1532 and Subpart B and C of 2 CFR Part 180.

A pre-bid meeting will be held on October 19, 2015 at 10:00 a.m. EST at the Project Site: 100 Big Indian Drive SW, Massillon, OH 44646.

The City reserves the right to waive irregularities and to reject any or all bids.

This project will be funded by the Water Pollution Control Loan Fund Program as administered by the Ohio Environmental Protection Agency and the Ohio Water Development Authority.

CITY OF MASSILLON

Safety Service Director
Joel Smith

INSTRUCTIONS TO BIDDERS

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A. BIDDER'S PLEDGE AND AGREEMENT

1. Each Bidder acknowledges that this is a public project involving public funds and that the Owner expects and requires that each successful Bidder adhere to the highest ethical and performance standards. Each Bidder by submitting a bid pledges and agrees that (a) it will act at all times with absolute integrity and truthfulness in its dealings with the Owner and the Design Professional, (b) it will use its best efforts to cooperate with the Owner and the Design Professional and all other Contractors on the Project and at all times will act with professionalism and dignity in its dealings with the Owner, Design Professional, and other Contractors, (c) it will assign only competent supervisors and workers to the Project, each of whom is fully qualified to perform the tasks that are assigned to him/her, and (d) it has read, understands and will comply with the terms of the Contract Documents.

B. EXAMINATION OF CONTRACT DOCUMENTS AND SITE CONDITIONS AND RELIANCE UPON TECHNICAL DATA

1. Each Bidder shall have a competent person carefully and diligently review each part of the Contract Documents, including the Divisions of the Specifications and parts of the Drawings that are not directly applicable to the Work on which the Bidder is submitting its bid. By submitting its bid, each Bidder represents and agrees, based upon its careful and diligent review of the Contract Documents, that it is not aware of any conflicts, inconsistencies, errors, or omissions in the Contract Documents for which it has not notified the Design Professional in writing at least ten (10) days prior to the bid opening. If there are any such conflicts, inconsistencies, errors, or omissions in the Contract Documents, the Bidder (i) will provide the labor, equipment, or materials of the better quality or greater quantity of Work and/or (ii) will comply with the more stringent requirements. The Bidder will not be entitled to any Change Order, additional compensation, or additional time on account of such conditions for any conflicts, inconsistencies, errors, or omissions that would have been discovered by such careful and diligent review, unless it has given prior written notice to the Design Professional.
2. Each Bidder shall have a competent person carefully and diligently inspect and examine the entire site and the surrounding area, including all parts of the site applicable to the Work for which it is submitting its bid, including location, condition, and layout of the site and the location of utilities, and carefully correlate the results of the inspection with the requirements of the Contract Documents. The Bidder's bid shall include all costs attributable to site and surrounding area conditions that would have been discovered by such careful and diligent inspection and examination of the site and the surrounding area, and the Bidder shall not be entitled to any Change Order, additional compensation, or additional time on account of such conditions.
3. The Bidder may rely upon the general accuracy of any technical data identified in the Owner-Contractor Agreement (e.g., any soils exploration reports, soil boring logs, site survey, or abatement reports) in preparing its bid, but such technical data are not part of the Contract Documents. Except for the limited reliance described in the preceding sentence, Bidder may not, if awarded a contract for the Work, rely upon or make any Claim against the Owner or Design Professional, or any of their agents or employees, with respect to any of the following:
 - a. the completeness of such reports and drawings for Bidder's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by the successful Bidder and safety precautions and programs incident thereto; or

- b. any interpretation by the successful Bidder of or conclusion drawn from any technical data or any such other data, interpretations, opinions, or information. For example, all interpolations and extrapolations of data performed by the Bidder to estimate locations or quantities of subsurface strata are independent factual assumptions, which Owner does not warrant.
4. Each Bidder will be deemed to have actual knowledge of all information provided or discussed at the pre-bid meeting.

C. OWNER & DESIGN PROFESSIONAL

1. The Owner is:

The City of Massillon
151 Lincoln Way East
Massillon, OH 44646

The Owner's Representative is:
Keith Dylewski, P.E., P.S.
Massillon City Engineer

2. The Design Professional (referred to as the "Design Professional" or "Engineer" in the Contract Documents) is:

CTI - O'Brien & Gere JV
220 Market South, Suite 750
Canton, OH 44702
(330) 455-7733

The Design Professional's Representative is William A. Dorman, P.E.

D. PROJECT

1. The Project and Work for the Project consists of all labor, materials, equipment, and services necessary for construction of the project identified as **2013 WWTP Improvements Project - Contract No. 2, General Construction** ("the Project"), all in accordance with the Drawings and Specifications prepared by the Design Professional. The Project must be substantially complete within 791 calendar days of Owner's issuance of the Notice to Proceed.

E. WORK

1. This Project entails the construction of improvements to the City of Massillon Regional Wastewater Treatment Plant, located at 100 Big Indian Drive SW, Massillon, Ohio 44646. The Project increases the rated capacity to 17-MGD and completes various modifications including BNR upgrade. Primary Effluent Pump Station (PEPS) pumps and Biological Treatment Integrated Fixed-Film Activated Sludge (IFAS) equipment were pre-purchased under separate contracts (1a, 1b). Contract 2 – General Construction – includes, but is not limited to: Fine Screens and building, Odor Control system, PEPS structure, Anaerobic/Anoxic tankage and IFAS retrofit, Tertiary Filtration replacement, Pre-Thickeners retrofit, Boiler Room, chemical feed, inter-unit piping, and ancillary systems (HVAC/Plumbing, Instrumentation & Control, Electrical).

2. Only one contract will be issued by the Owner for constructing the Project, the General Contract, which will cover all scopes of work necessary to construct the Project.
3. The Contractor awarded the General Contract (General Contractor) will be responsible for the performance and coordination of any and all subcontractors and suppliers either directly or indirectly contracted with the General Contractor.
4. Owner will provide Bidders access to the Project site to conduct such examinations, investigations, explorations, tests, and studies as Bidder deems necessary for submission of a Bid. Bidder shall fill all holes, clean up, and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies. Bidder shall comply with all applicable laws, regulations and Owner's policies relative to excavation and utility locates. Bidders may contact Dave Henderson at (330) 833-3304 if they have any interest in accessing the Project site, independent of the pre-bid meeting.

F. ESTIMATE OF COST

1. The total estimated construction cost for the Base Bid Work for the Project for which bids are being solicited at this time is \$27,432,309.00.

G. CONTRACT DOCUMENTS

The Contract Documents consist of the documents listed in Section 1 of the Owner-Contractor Agreement.

Contract Documents must be obtained from the following website: <http://bid.obg.com>. Interested parties are required to register on the website for the ability to view and/or acquire the Bidding Documents for the Project. It is the responsibility of any person or organization interested in a hard copy of the Bidding Documents to pay all costs associated with printing.

Bidders shall use complete sets of Contract Documents in preparing bids. Neither the Owner nor the Design Professional assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Contract Documents.

The Owner or the Design Professional, in making the Contract Documents available on the above terms, does so only for the purpose of obtaining bids on the Work and does not confer a license or grant for any other use.

A pre-bid conference will be held at 10:00 a.m. on October 19, 2015 at the Project Site: 100 Big Indian Drive SW, Massillon, Ohio 44646.

H. PREPARATION OF BIDS

1. All bids must be submitted on the "Bid Form" furnished with the Contract Documents.
2. All blank spaces shall be filled in, in ink or typewritten, in words and figures, and in figures only where no space is provided for words, and signed by the Bidder. The wording on the Bid Form shall be used without change, alteration, or addition. Any change in the wording or omission of specified accompanying documents may cause the bid to be rejected. If there is an inconsistency or conflict in the Bid, the lowest amount shall control, whether expressed in numbers or words.
3. Bidders shall note receipt of Addenda on the Bid Form. If the Bidder fails to acknowledge receipt of each Addendum, the Bid shall be deemed non-responsive, unless the Bid amount clearly and unambiguously reflects receipt of the Addendum or the Addendum

involves only a matter of form and does not materially affect the price, quantity or quality of the Work to be performed.

4. Each Bidder shall submit **an original and one copy** of its bid to the Owner. The Bid Form shall be signed with the name typed or printed below the signature. A Bid shall not be submitted by facsimile transmission. A Bidder that is a corporation shall sign its bid with the legal name of the corporation followed by the name of the state of incorporation and the legal signature of an officer authorized to bind the corporation to a contract.
5. Each Bid shall be enclosed in a sealed opaque envelope with the Bidder's name and the title of the Project printed in the upper left hand corner and addressed as follows:

The City of Massillon
Attn: Joel Smith, Director of Public Service and Safety
151 Lincoln Way East
Massillon, OH 44646

Bids must be received at the designated location for the bid opening before 2:00 p.m., local time, on November 6, 2015.

6. **The completed Bid Form shall be accompanied by the following completed documents:**
 - a. **Bid Guaranty and, if applicable, Contract Bond (See Paragraph H.8, below.)**
 - b. **Contractor's Qualification Statement (See Paragraph I.4, below.)**
 - c. **A completed Form 6100-4 (DBE Subcontractor Utilization Form) demonstrating that Contractor has met the DBE participation goals.**
 - d. **Also, for each MBE and WBE subcontractor identified in 6100-4, the bidder must submit with its bid a completed 6100-3 (Individual DBE Subcontractor Proposed Performance Form). See Section W, below, for further information**
 - e. **If the DBE goals are not met, documentation of the Bidder's Good Faith Efforts to secure the stated goals for MBE and DBE participation in the Project, including a written explanation (with any exhibits). See Section W, below, for further information.**
 - f. **Equal Employment Opportunity Certification.**
 - g. **Certification Regarding Debarment, Suspension, and Other Responsibility Matters.**
7. The Bidder shall take the following precautions in preparing its bid:
 - a. Sign the bid and check to ensure all blank spaces have been filled in with requested information and that the specified accompanying documents (listed in Paragraph H.6 above) have been included in a sealed opaque envelope addressed as described in Paragraph 5 above.

- b. When the Bid Form provides for quoting either an addition or deduction for an Alternate item, indicate whether the sum named is an addition or deduction. If it is not indicated, it will be conclusively presumed that the amount is a deduction.
- c. When the Bid Form provides for quoting a unit price, the Bidder should quote the unit price as set forth in the Bid Documents.
- d. When applicable, make sure that the Bid Guaranty is properly executed and signed by:
 - 1) The Bidder
 - 2) The Surety or Sureties
- e. Make sure that the amount of the Bid Guaranty (if the Bid Guaranty is in the form of a certified check, letter of credit, or cashier's check) is for a specific sum in an amount as instructed in Paragraph H.8.a below. If the Bid Guaranty is in the form of the Bid Guaranty and Contract Bond, the amount may be left blank; if an amount is inserted, it must equal the total of the base bid and any add alternates included. If inserted, then the failure to state an amount equal to the total of the base bid and any add alternates shall make the bid non-responsive if the Owner selects alternates not included in the amount.

8. Bonds and Guarantees

- a. Bid Guaranty: Bidder shall furnish a Bid Guaranty, as prescribed in Sections 153.54, 153.57, and 153.571 of the Ohio Revised Code, in the form of either: (1) a bond for the full amount of the bid in the form of the Bid Guaranty and Contract Bond included in the Bid Documents; or (2) a certified check, cashier's check, or irrevocable letter of credit in a form satisfactory to the Owner in an amount equal to 10% of the bid. Bid amount shall be the total of all sums bid, including all add alternatives, but excluding all deduct alternatives. NOTE: AIA or EJCDC Bid Bond forms are not acceptable.
- b. Contract Bond: The successful Bidder, who, as a Bid Guaranty, submits a certified check, cashier's check, or irrevocable letter of credit in an amount equal to 10% of the bid, shall furnish a Contract Bond in the form included in the Bid Documents in an amount equal to 100% of the Contract Sum. NOTE: AIA or EJCDC Bond forms are not acceptable.
- c. The bond must be issued by a surety company authorized by the Ohio Department of Insurance to transact business in the State of Ohio and acceptable to the Owner. The bond must be issued by a surety capable of demonstrating a record of competent underwriting, efficient management, adequate reserves, and sound investments. These criteria will be deemed to be met if the surety currently has an A.M. Best Company Policyholders Rating of "A-" or better and has or exceeds the Best Financial Size Category of Class VI. Other sureties may be acceptable to the Owner, in its sole discretion.
- d. All bonds shall be signed by an authorized agent of an acceptable surety and by the Bidder.
- e. Surety bonds shall be supported by credentials showing the Power of Attorney of the agent, a certificate showing the legal right of the Surety

Company to do business in the State of Ohio, and a financial statement of the Surety.

- f. The Bid Guaranty, as applicable, shall be in the name of or payable to the order of the City of Massillon.
- g. The name and address of the Surety and the name and address of the Surety's Agent must be typed or printed on each bond.

I. METHOD OF AWARD

1. All bids shall remain open for acceptance for sixty (60) days following the day of the bid opening, but the Owner may, in its sole discretion, release any bid and return the Bid Guaranty prior to that date. The Bid Guaranty shall be subject to forfeiture, as provided in the Ohio Revised Code, if a bid is withdrawn during the period when bids are being held.
2. The Owner reserves the right to reject any, part of any, or all bids and to waive any informalities and irregularities. The Bidder expressly acknowledges this right of the Owner to reject any or all bids or to reject any incomplete or irregular bid. Bidders must furnish all information requested on the Bid Form. Failure to do so may result in disqualification of the bid.
3. Determination of the Lowest and Best Bid. Subject to the right of the Owner to reject any or all bids, Owner will award the Contract for the Work to the bidder submitting the lowest and best bid, taking into consideration any accepted alternates. In evaluating bids, the Owner will consider the qualifications of the Bidders, whether or not the bids comply with the prescribed requirements, and alternates and unit prices, if requested, on the Bid Form. The Owner may also consider the qualifications and experience of subcontractors and suppliers. The Owner may conduct such investigations as are deemed necessary to establish the qualifications and financial ability of the Bidder and its subcontractors and suppliers. The factors the Owner may consider in determining which bid is lowest and best include the factors set forth below, including the Additional Criteria. Depending upon the type of the work, the Owner, in its discretion, may also consider other essential factors, as the Owner may determine and as are included in the Specifications. The Owner, in its discretion, may consider and give such weight to these criteria as it deems appropriate. The Owner, in its discretion, reserves the right to request additional information and documentation relating to these criteria from Bidders after the bid opening.
 - a. Work to be subcontracted. The Bidder must identify all work to be subcontracted where the value of the subcontracted work is greater than \$50,000.00. See paragraph I.9 below. All subcontractors are subject to the approval of the Owner based on the criteria set forth in this Section I.
 - b. The Bidder's work history. The Bidder should have a record of consistent customer satisfaction and of consistent completion of projects, including projects that are comparable to or larger and more complex than the Owner's Project, on time and in accordance with the applicable Contract Documents, and based upon the Bidder's claims history. If the Bidder's management operates or has operated another construction company, the Owner may consider the work history of that company in determining whether the Bidder submitted the lowest and best bid.

The Owner will consider the Bidder's prior experience on other projects of similar scope and/or complexity including prior projects with the Owner and/or Design Professional, including the Bidder's demonstrated ability to complete its work on

these projects in accordance with the Contract Documents and on time, and will also consider its ability and capacity to perform a substantial portion of the project with its own forces and its ability to work with the Owner and Design Professional as a willing, cooperative, and successful team member. Bringing overstated claims, an excessive number of claims, acting uncooperatively, and filing lawsuits against project owners and/or their design professionals on prior projects of similar scope and/or complexity will be deemed evidence of a Bidder's inability to work with the Owner and Design Professional as a willing, cooperative, and successful team member.

The Bidder authorizes the Owner and its representatives to contact the owners and design professionals (and construction managers, if applicable) on projects on which the Bidder has worked and authorizes and requests such owners and design professionals (and construction managers) to provide the Owner with a candid evaluation of the Bidder's performance. By submitting its bid, the Bidder agrees that if it or any person, directly or indirectly, on its behalf or for its benefit brings an action against any of such owners or design professionals (or construction managers) or the employees of any of them as a result of or related to such candid evaluation, the Bidder will indemnify and hold harmless such owners, design professionals (and construction managers) and the employees of any of them from any claims, whether or not proven, that are part of or are related to such action and from all legal fees and expenses incurred by any of them arising out of or related to such legal action. This obligation is expressly intended for the benefit of such owners, design professionals (and construction managers), and the employees of each of them.

- c. The Bidder's prior history regarding timeliness of performance, quality of work, the Bidder's history of filing claims and having claims filed against it, extension requests, fines and penalties imposed and payments thereof, and contract defaults, with explanations.
- d. The Bidder's compliance with federal, state, and local laws, rules, and regulations, including but not limited to the Occupational Safety and Health Act, the Ohio Prevailing Wage laws, and Ohio ethics laws.
- e. The Bidder's prior experience with similar work on comparable or more complex projects.
- f. The number of years the Bidder has been actively engaged as a contractor in the construction industry.
- g. The Bidder's recent experience record in the construction industry, including the original contract price for each construction job undertaken by the bidder, the amount of any change orders or cost overruns on each job, the reasons for the change orders or cost overruns, and the bidder's record for complying with and meeting completion deadlines on construction projects.
- h. A public entities' determination, within the previous five years, that the Bidder was not a responsible bidder, the reasons given by the public entity, and the Bidder's explanation thereof.
- i. The Bidder's financial ability to complete the Contract successfully and on time without resort to its Surety.
- j. Financial responsibility demonstrated by the Bidder and whether Bidder possesses adequate resources and availability of credit, the means and ability to procure insurance and acceptable performance bonds required for the Project

and whether any claims have been made against performance bonds secured by the bidder on other construction projects.

- k. Any suspension or revocations of any professional license of any director, officer, owner, or managerial employees of the Bidder, to the extent that any work to be performed on this Project is within the field of such licensed profession.
- l. The Bidder's equipment and facilities.
- m. The size and experience, of the Bidder's work force and the Bidder's ability to complete the Contract successfully and on time.
- n. The experience and the continuity of the Bidder's work force including the project manager and project superintendent's tenure with the Bidder.
- o. The Bidder's participation in a drug-free workplace program acceptable to the Owner, and the Bidder's record for both resolved and unresolved findings of the Auditor of State for recovery as defined in Section 9.24 of the Ohio Revised Code.
- p. The Owner's prior experience with the Bidder's surety.
- q. The Bidder's interest in the Project as evidenced by its attendance at any pre-bid meetings or conferences for bidders.
- r. The foregoing information with respect to each of the Subcontractors and Suppliers that the Bidder intends to use on the Project.

4. **Qualifications Statement.** Each Bidder will submit with its bid a completed Contractor Qualifications Statement, which is included with the Project Manual, and thereafter provide the Engineer promptly with such additional information as the Engineer may request regarding the Bidder's qualifications. A Bidder shall submit any requested additional information within three (3) business days of the date on the request.

5. **(Reserved.)**

6. **Additional Criteria for Determining Lowest and Best Bid.** Owner reserves the right to request additional information and documentation, including but not limited to information and documentation relating to the following factors, from Bidders after the bid opening. The Owner may consider such information and documentation in determining which bid is lowest and best. The Owner, in its discretion, may consider and give such weight to these criteria as it deems appropriate.

- a. Any and all OSHA citations within the previous three years, together with the Bidder's description and explanation of remediation or other steps taken regarding such citations and notices of citations.
- b. Any and all violations within the previous five years pertaining to unlawful intimidation or discrimination against any employee by reason of race, creed, color, disability, gender, or national origin and/or violation of any employee's civil or labor rights or equal employment opportunities.
- c. Any litigation in which the Bidder has been named as a defendant or third party defendant in an action involving a claim for personal injury or wrongful death arising from performance of work related to any project in which it has been engaged within the previous five years.

- d. Any violations of the prevailing wage law and any other state or federal labor law, including, but not limited to, child labor violations, failure to pay wages, or unemployment insurance tax delinquencies or unfair labor practices within the past five years.
 - e. Violations of the workers compensation law.
 - f. Any criminal convictions or criminal indictments, involving the Bidder, its officers, directors, owners, and/or managers within the past five years.
 - g. Any violation within the past five years or pending charges concerning federal, state, or municipal environmental and/or health laws, codes, rules and/or regulations.
 - h. Documentation that the Bidder provides health insurance and pension benefits to its employees.
 - n. Whether the Bidder participates in a bona fide apprenticeship program that is approved by the Ohio State Apprenticeship Council and the United States Department of Labor.
 - o. Whether the Bidder has adopted and implemented a comprehensive drug and alcohol testing program for its employees.
 - p. Whether the Bidder's employees are OSHA-10 hour and/or OSHA-30 hour safety certified.
 - r. The foregoing information with respect to each of the Subcontractors and Suppliers that the Bidder intends to use on the Project.
7. The failure to submit requested information on a timely basis may result in the determination that the Bidder has not submitted the lowest and best bid.
8. By submitting its bid, the Bidder agrees that the Owner's determination of which bidder is the lowest and best bidder shall be final and conclusive, and that if the Bidder or any person on its behalf challenges such determination in any legal proceeding, the Bidder will indemnify and hold the Owner and its employees and agents harmless from any claims included or related to such legal proceeding, and from legal fees and expenses incurred by the Owner, its employees, or agents that arise out of or are related to such challenge.
9. **After bid opening, within three (3) business days of a request made by the Design Professional, the apparent low Bidder and any other Bidder so requested by the Engineer or Owner must submit the following:**

For all subcontracts with an estimated value of at least \$50,000, a list of all Subcontractors that the Bidder will use to construct the Project, as well as an indication of whether or not the Bidder has ever worked with a proposed Subcontractor before, including the following information for the three most recent projects on which the Bidder and each Subcontractor have worked together:

- i. **Project Owner**
- ii. **Project Name**
- iii. **Subcontract Scope**
- iv. **Subcontract Value**

v. Owner's contact name and phone number.

If Bidder and a proposed Subcontractor have not worked together on at least three projects in the past five years, Bidder must submit the information set forth above for the three most recent similar projects to the Project that a proposed Subcontractor has worked on.

The above Subcontractor information, as well as the criteria set forth in Paragraph I.3 herein, as it pertains to each Subcontractor may be used in the Owner's determination of the lowest and best bid.

Once a Bidder identifies its proposed Subcontractors as set forth in this Paragraph I.9, the list shall not be changed unless written approval or direction for the change is made by Owner.

10. Additional Post-Bid Submittals

- a) Affidavit as to Personal Property Taxes. The successful Bidder shall submit, prior to the time of the entry into the Contract, an affidavit in the form required by Section 5719.042, Ohio Revised Code, regarding the status of the Bidder's personal property taxes. A copy of the affidavit form is included with the Contract Documents.
- b) American Steel & Iron Acknowledgement. The successful Bidder shall submit, prior to the time of the entry into the Contract, an executed American Steel & Iron Acknowledgement. A copy of the acknowledgement form along with guidance documents for reference, is included with the Contract Documents.

- 11. No Bidder may withdraw its bid within sixty (60) days after the date bids are opened. The Owner reserves the right to waive any formalities or irregularities or to reject any or all bids.
- 12. The Owner reserves the right to disqualify bids, before or after opening, upon evidence of collusion with intent to defraud or other illegal practices on the part of the Bidder.
- 13. Award of Contract. The award of the Contract, when required, will only be made pursuant to City of Massillon Board of Control approval.

J. EXECUTION OF CONTRACT

- 1. Within the time designated by the City of Massillon after award of the Contract, the successful Bidder shall execute and deliver to the City of Massillon the required number of copies of the Owner-Contractor Agreement, in the form included in the Contract Documents, and all accompanying documents requested, including, but not limited to, a Contract Bond (if applicable), insurance certificates, and a valid Workers' Compensation Certificate. The successful Bidder shall have no property interest or rights under the Owner-Contractor Agreement until the Agreement is executed by the Owner.

K. SUBSTITUTIONS/NON-SPECIFIED PRODUCTS

- 1. Certain brands of material or apparatus are specified. Each bid will be based on these brands, which may be referred to in the Contract Documents as Standards. The following will be cause for rejection of a proposed substitution:

L. UNIT PRICES

1. Where unit prices are requested in the Bid Form the Bidder should quote a unit price. Unless otherwise expressly provided in the Bid Documents, such unit prices shall include all labor, materials, and services necessary for the timely and proper installation of the item for which the unit prices are requested. The unit prices quoted in the bid shall be the basis for any Change Orders entered into under the Owner-Contractor Agreement, unless the Design Professional determines that the use of such unit prices will cause substantial inequity to either the Contractor or the Owner.

M. ADDENDA

1. The Owner reserves the right to issue Addenda changing, altering, or supplementing the Contract Documents prior to the time set for receiving bids. The Design Professional will issue the Addenda to clarify bidders' questions and/or to change, alter, or supplement the Contract Documents.
2. Any explanation, interpretation, correction, or modification of the Contract Documents will be issued in writing in the form of an Addendum, which shall be the only means considered binding; explanations, interpretations, etc., made by any other means shall NOT be legally binding. All Addenda shall become a part of the Contract Documents.
3. All Addenda will be issued, except as hereafter provided, and mailed or otherwise furnished to persons who have obtained Contract Documents for the Project, at least seventy-two (72) hours prior to the published time for the opening of bids, excluding Saturdays, Sundays, and legal holidays. If any Addendum is issued within such seventy-two (72) hour period, then the time for opening of bids shall be extended one (1) week with no further advertising of bids required.
4. Copies of each Addendum will be sent only to the Bidders to whom Contract Documents have been issued and to Plan Rooms where copies of the Contract Documents are maintained. Receipt of Addenda shall be indicated by Bidders in the space provided on the Bid Form. Bidders are responsible for acquiring issued Addenda in time to incorporate them into their bid. Bidders should contact the Design Professional prior to the bid opening to verify the number of Addenda issued.
5. Each Bidder shall carefully read and review the Contract Documents and immediately bring to the attention of the Design Professional any error, omission, inconsistency, or ambiguity therein.
6. If a Bidder fails to indicate receipt of all Addenda through the last Addendum issued by the Design Professional on its Bid Form, the bid of such Bidder will be deemed to be responsive only if:
 - a. The bid received clearly indicates that the Bidder received the Addendum, such as where the Addendum added another item to be bid upon and the Bidder submitted a bid on that item; or
 - b. The Addendum involves only a matter of form or is one which has either no effect or has merely a trivial or negligible effect on price, quantity, quality, or delivery of the item bid upon.

N. INTERPRETATION

1. If a Bidder contemplating submitting a bid for the proposed Project is in doubt as to the true meaning of any part of the Contract Documents, it may submit a written request for an interpretation thereof to the Design Professional's representative via email at

2013MassillonWWTP@ctiengr.com or via fax at (330) 313-2282. Requests received fewer than 7 days prior to bid opening may not be answered. Any interpretation of the proposed documents will be made by Addendum only, duly signed by the Design Professional, and a copy of such Addendum will be mailed or delivered to each Bidder receiving a set of Contract Documents and each plan room where the Contract Documents are maintained. The Owner will not be responsible for any other explanation or interpretation of the proposed documents.

2. In interpreting the Contract Documents, words describing materials that have a well-known technical or trade meaning, unless otherwise specifically defined in the Contract Documents, shall be construed in accordance with the well-known meaning recognized by the trade.
3. Bidders are responsible for notifying the Design Professional in a timely manner of any ambiguities, inconsistencies, errors, or omissions in the Contract Documents. The Bidder shall not, at any time after the execution of the Contract, be compensated for a claim alleging insufficient data, incomplete Contract Documents, or incorrectly assumed conditions regarding the nature or character of the Work, if no request was made by the Bidder prior to the bid opening.

O. STATE SALES AND USE TAXES

1. The Owner is a political subdivision of the State of Ohio and is exempt from taxation under the Ohio Sales Tax and Use Tax Laws. Building materials that the successful Bidder purchases for incorporation into the Project will be exempt from state sales and use taxes if the successful Bidder provides a properly completed Ohio Department of Taxation Construction Contract Exemption Certificate to the vendors or suppliers when the materials are acquired. The Owner will execute properly completed certificates on request.

P. DATE FOR SUBSTANTIAL COMPLETION/LIQUIDATED DAMAGES

1. Dates for Substantial Completion. The Contract Time shall run from the date of the Notice to Proceed or if there is no Notice to Proceed from the Effective Date of the Owner-Contractor Agreement. The Date for Substantial Completion Date and the Contract Time may be extended only by Change Order, by other Modification, or by a Claim that is Finally Resolved. **By submitting its Bid, each Bidder agrees that the period for performing its Work is reasonable.**

- a. Date for Overall Project Substantial Completion. The successful Bidder shall have all of its Work on the Project Substantially Complete (as Substantial Completion is defined in the Contract Documents) by the following date or within the Contract Time, as applicable to the Bidder's scope of work.

Date for Substantial Completion (aka Contract Time) expressed as calendar days from Notice to Proceed:

791 calendar days

2. Liquidated Damages.
 - a. Overall Project Substantial Completion. If the successful Bidder does not have its Work Substantially Complete by its Date for Substantial Completion or Finally Complete within forty-five (45) days of achieving Substantial Completion, whichever may be applicable, the successful Bidder shall pay the Owner and the Owner may set off from amounts otherwise due the successful Bidder Liquidated Damages. The daily amounts of Liquidated Damages for Overall Project

Substantial Completion are set forth in the tables included in the Owner-Contractor Agreement. The total amount of Liquidated Damages will be calculated based on the total number of calendar days beyond the Date for Substantial Completion that the Bidder's Work is not Substantially Complete or to the extent that its Work is not Finally Complete more than forty-five (45) days after the Substantial Completion of its Work, i.e., number of late days times the per diem rate(s) for Liquidated Damages in the tables.

3. The Bidder acknowledges and agrees, by submitting its bid for the Work and entering into a Contract with the Owner, that such amounts of Liquidated Damages represent a reasonable estimate of the actual damages for loss of or interference with the intended use of the Project that the Owner would incur if the Bidder's Work is not Substantially Complete by its Date for Substantial Completion and/or not Finally Complete by forty-five (45) days of the Date of Substantial Completion. The Bidder further acknowledges, agrees and understands that it may seek an extension of the Contract Time (and its Date for Substantial Completion) to avoid or reduce Liquidated Damages by properly following the Claim procedures in the Contract Documents.

Q. OWNER'S RIGHT TO WAIVE DEFECTS AND IRREGULARITIES

1. The Owner reserves the right to waive any and all irregularities provided that the defects and irregularities do not affect the amount of the bid in any material respect or otherwise give the Bidder a competitive advantage.

R. MODIFICATION/WITHDRAWAL OF BIDS

1. Modification. A Bidder may modify its bid by written communication to the Owner addressed to the Owner's Representative at any time prior to the scheduled closing time for receipt of bids, provided such written communication is received by Owner's Representative prior to the bid deadline. The written communication shall not reveal the bid price, but should provide the addition or subtraction or other modification so that the final prices or terms will not be known until the sealed bid is opened. If the Bidder's written instructions with the change in bid reveal the bid amount in any way prior to the bid opening, the bid may be rejected as non-responsive.
2. Withdrawal Prior to Bid Deadline. A Bidder may withdraw its bid at any time for any reason prior to the bid deadline for the opening of bids established in the Legal Notice. The request to withdraw shall be made in writing to and received by the Owner's Representative prior to the time of the bid opening.
3. Withdrawal after Bid Deadline.
 - a. All bids shall remain valid and open for acceptance for a period of at least 60 days after the bid opening; provided, however, that a Bidder may withdraw its bid from consideration after the bid deadline when all of the following apply:
 - (1) the price bid was substantially lower than the other bids;
 - (2) the reason for the bid being substantially lower was a clerical mistake, rather than a mistake in judgment, and was due to an unintentional and substantial error in arithmetic or an unintentional omission of a substantial quantity of work, labor, or material;

- (3) the bid was submitted in good faith; and
 - (4) the Bidder provides written notice to the Owner, to the attention of the Owner's Representative, within two (2) business days after the bid opening for which the right to withdraw is claimed.
- b. No bid may be withdrawn under this provision if the result would be the awarding of the contract on another bid for the bid package from which the Bidder is withdrawing its bid to the same Bidder.
 - c. If a bid is withdrawn under this provision, the Owner may award the Contract to another Bidder determined by the Owner to be the lowest and best bidder or the Owner may reject all bids and advertise for other bids. In the event the Owner advertises for other bids, the withdrawing Bidder shall pay the costs incurred in connection with the rebidding by the Owner, including the cost of printing new Contract Documents, required advertising, and printing and mailing notices to prospective bidders, if the Owner finds that such costs would not have been incurred but for such withdrawal.

S. COMPLIANCE WITH APPLICABLE LAWS

- 1. By submitting a bid for Work on the Project, the Bidder acknowledges that it is in compliance with applicable federal, state, and local laws and regulations, including, but not limited to, the following:
 - a. Equal Employment Opportunity/Nondiscrimination. The Bidder agrees that if it is awarded a contract that in the hiring of employees for performance of work under the contract or any subcontract, neither it nor any subcontractor, or any person acting on its behalf or its subcontractor's behalf, by reason of race, creed, sex, disability as defined in Section 4112.01 of the Ohio Revised Code, or color, shall discriminate against any citizen of the state in the employment of labor or workers who are qualified and available to perform work to which the employment relates. The Bidder further agrees that neither it nor any subcontractor or any person on its behalf or on behalf of any subcontractor, in any manner, shall discriminate against or intimidate any employees hired for the performance of the work under the contract on account of race, creed, sex, disability as defined in Section 4112.01 of the Ohio Revised Code, or color.
 - b. Ethics Laws. The Bidder represents that it is familiar with all applicable ethics law requirements, including without limitation Sections 102.04 and 3517.13 of the Ohio Revised Code, and certifies that it is in compliance with such requirements.

T. FINDINGS FOR RECOVERY

- 1. By submitting its bid, each Bidder certifies for reliance of the Owner that it has no unresolved finding for recovery against it issued by the Auditor of the State of Ohio on or after January 1, 2001, except as permitted by Section 9.24 (F) of the Ohio Revised Code.

U. PREVAILING WAGES

- 1. The prevailing wage rates of the Department of Labor (Davis-Bacon Act), as set forth in General Wage Decision Number: OH150002 08/21/2015 OH2 (included in the Project Manual) apply to this project. The Labor Standards Provisions found at 29 CFR 5.5(a) also apply to this project, as well as provisions of the Contract Work Hours and Safety Standards Act at 29 CFR 5.5(b).

V. DBE PARTICIPATION GOALS

1. The Project is funded in part by U.S. EPA's Water Pollution Control Loan Fund ("WPCLF"), and so is subject to Federal statutes and regulations designed to encourage Project participation for historically Disadvantaged Business Enterprises and ensure nondiscrimination. "DBE" is an all inclusive term that includes Minority Business Enterprises (MBE), Women Business Enterprises (WBE), Small Business Enterprises (SBE), Small Business in Rural Areas (SBRA), HUBZone Small Business, Labor Surplus Area Firms (LSAF), and other entities defined as socially and/or economically disadvantaged. Participation by all disadvantaged groups is strongly encouraged and U.S. EPA and Ohio EPA have established the following "fair share" DBE participation goals for the Project:

Minority Business Enterprise ("MBE")	1.2%
Woman-Owned Business Enterprise ("WBE")	1.8%

Under the DBE program, qualified DBE's are those that have been certified as an MBE or WBE. Any MBE or WBE proposed as a participant in the Project must be certified at bid time as a DBE under Ohio's Unified Certification Program administered by the Ohio Department of Transportation and then must provide sufficient evidence that it is a bona fide MBE or WBE, to the sole satisfaction of Owner. To qualify for MBE certification, businesses must be 51 percent owned and controlled by a U.S. citizen and Ohio resident belonging to an African-American, Native American, Hispanic, or Oriental ethnic group. In addition, the business must be in operation for at least one year prior to submitting an application. For DBE status, a business must be at least 51 percent owned by a socially and economically disadvantaged person who participates in the daily operations of the business. This person must be a woman or of African-American, Hispanic, Native American, Asian-Pacific or Asian Subcontinent ethnicity.

2. **Documentation of DBE Participation.** Each Bidder must submit with its bid a completed Form 6100-4 (DBE Subcontractor Utilization Summary) identifying its MBE and WBE subcontractors and participation rates. A blank DBE Subcontractor Utilization Summary is included in the Project Manual.

Also, for each MBE and WBE subcontractor identified in Form 6100-4, each bidder must submit with its bid a completed Form 6100-3 (Individual DBE Subcontractor Proposed Performance Form). A blank Individual DBE Subcontractor Proposed Performance Form is included in the Project Manual.

3. **Certification of Good Faith Efforts.** If a Bidder has not achieved the "fair share" participation goals when soliciting subcontracts, the Contractor must follow, document, and *submit such documentation with its Bid*, and maintain documentation of the Good Faith Efforts listed below to secure DBE participation in the Project, such as, but not necessarily limited to the following:

- Ensuring that DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities; including DBEs on solicitation lists and soliciting them whenever they are potential sources.
- Making information on forthcoming opportunities available to DBEs and arrange time frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. This includes, whenever

possible, posting solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.

- **Dividing work, when economically feasible, into smaller tasks or quantities to permit participation by DBEs in the competitive process.**
- **Contracting with a consortium of DBEs when a contract is too large for one of these firms to handle individually.**
- **Using the services and assistance of the Small Business Administration and the Minority Business Development Agency of the U.S. Department of Commerce.**

Owner, in its sole discretion, but possibly after consultation with one or more State or Federal Agencies, will be the sole evaluator of whether any particular Bidders' efforts sufficiently demonstrate good faith efforts for securing DBE participation.

4. Challenges to Owner's Discretion. If any Bidder directly challenges, or indirectly challenges through contribution of money or other resources to a third party, Owner's discretion in determining any Bidder's compliance with the DBE goals stated in these Instructions to Bidders, or good faith efforts pertaining to same, that Bidder agrees to indemnify Owner for all claims, costs, losses and damages, including attorney and consultant fees, arising out of such challenge, should there be an adjudication by a court of competent jurisdiction that the Owner did not abuse its discretion.
5. Documenting Compliance.
 - a) Also included in the Project Manual is a copy of Form 6100-2 (DBE Participation Form). If a Bidder is awarded a contract for the Project, it must provide a copy of the DBE Participation Form to each of its DBE subcontractors and suppliers. Disadvantaged Business Enterprise subcontractors are to send completed Form 6100-2 directly to the Region 5 DBE Coordinator as set forth below or as updated:

Adrianne M. Callahan, Region 5 MBE/WBE Coordinator
USEPA, Acquisition and Assistance Branch
77 West Jackson Boulevard (MC-10J)
Chicago, IL 60604
 - b) If a Bidder is awarded a contract for the Project, it must provide the Owner with the data necessary for the Owner to report the MBE/WBE accomplishments on Form 5700-52A. A copy of such Form is available from the Owner, upon written request.
6. Failure to Comply. If a Bidder is awarded a contract for the Project, and later fails to fulfill its stated DBE participation goals, that Bidder agrees to indemnify Owner for all claims, costs, losses and damages, including attorney and consultant fees, arising out of such failure. That Bidder also agrees to cooperate with all reasonable requests to determine actual DBS participation.

W. OTHER FEDERAL REQUIREMENTS

1. This procurement is subject to the EPA policy of encouraging the participation of small businesses in rural areas. It is EPA policy that recipients of EPA financial assistance awards utilize the services of small businesses in rural areas (SBRA), to the maximum extent practicable. The objective is to assure that such small business entities are afforded the maximum practicable opportunity to participate as subcontractors, suppliers and otherwise in EPA-awarded financial assistance programs. This policy applies to all contracts and subcontracts for supplies, construction, and services under EPA grants or cooperative agreements. Small purchases are also subject to this policy.

END OF INSTRUCTIONS TO BIDDERS

BID FORM

1.01 BID SUBMITTED BY:

(Contractor)

Date bid submitted: _____

1.02 DELIVER TO:

The City of Massillon
Attn: Joel Smith, Director of Public Safety and Service
151 Lincoln Way East
Massillon OH 44646

1.03 Having carefully reviewed the Instructions to Bidders, Drawings, Specifications and other Contract Documents for the Project titled **2013 WWTP Improvements Project - Contract No. 2, General Construction** including having also received, read, and taken into account the following Addenda:

Addendum No.	Dated
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

and likewise having inspected the site and the conditions affecting and governing the Project, the undersigned hereby proposes to furnish all materials and to perform all labor, as specified and described in the said Specifications and/or as shown on the said Drawings for all Work necessary to complete the Project on a timely basis and in accordance with the Contract Documents regardless of whether expressly provided for in such Specifications and Drawings.

1.04 Before completing the Bid Form, the undersigned represents that it has carefully reviewed the Legal Notice to Bidders, Instructions to Bidders, this Bid Form, Form of Bid Guaranty and Contract Bond, Contractor's Affidavit (O.R.C. 5719.042), Owner-Contractor Agreement, General Conditions of the Contract (EJCDC C-700, 2002) (as modified), Drawings, Project Specifications, and other Contract Documents. Failure to comply with provisions of the Contract Documents may be cause for disqualification of the bid.

1.05 BONDS AND CONTRACT: If the undersigned is notified of bid acceptance, it agrees to furnish required bonds as indicated in the Instructions to Bidders.

1.06 COMPLETION OF WORK: In submitting a bid, the undersigned agrees to execute the Owner-Contractor Agreement in the form included in the Contract Documents and to substantially complete its Work as required by the Contract Documents.

NOTE A: The wording of the Bid Form shall be used throughout, without change, alteration, or addition. Any change may cause it to be rejected.

NOTE B: Bidder is cautioned to bid only on the Brands or Standards specified.

2.01 BID:

Include the cost of all labor and material for the contract identified in Exhibit A to these Instructions to Bidders. Bidder is to fill in all blanks related to the Bid Package for which a bid is being submitted. If no bid is submitted for an item, leave the item blank or insert "NO BID" in the blank. For any alternate items, if applicable, indicate whether the amount stated is in addition to or a deduction from the base bid amount (if there is no indication whether the amount for an alternate is an addition or a deduction, the amount shall be a deduction).

3.01 INSTRUCTIONS FOR SIGNING

- A. The person signing for a sole proprietorship must be the sole proprietor or his authorized representative. The name of the sole proprietor must be shown below.
- B. The person signing for a partnership must be a partner or his authorized representative.
- C. The person signing for a corporation must be the president, vice president or other authorized representative; or he must show authority, by affidavit, to bind the corporation.
- D. The person signing for some other legal entity must show his authority, by affidavit, to bind the legal entity.

4.01 BIDDER CERTIFICATIONS. The Bidder hereby acknowledges that the following representations in this bid are material and not mere recitals:

- 1. **The Bidder acknowledges that this is a public project involving public funds, and that the Owner expects and requires that each successful Bidder adhere to the highest ethical and performance standards. The Bidder by submitting its bid pledges and agrees that (a) it will act at all times with absolute integrity and truthfulness in its dealings with the Owner and the Design Professional, (b) it will use its best efforts to cooperate with the Owner and the Design Professional and all other Contractors on the Project and at all times will act with professionalism and dignity in its dealings with the Owner, Design Professional and other Contractors, (c) it will assign only competent supervisors and workers to the Project, each of whom is fully qualified to perform the tasks that are assigned to him/her, and (d) it has read, understands and will comply with the terms of the Contract Documents.**
- 2. The Bidder represents that it has had a competent person carefully and diligently review each part of the Contract Documents, including any Divisions of the Specifications and parts of the Drawings that are not directly applicable to the Work on which the Bidder is submitting its bid. By submitting its bid, each Bidder represents and agrees, based upon its careful and diligent review of the Contract Documents, that it is not aware of any conflicts, inconsistencies, errors or omissions in the Contract Documents for which it has not notified the Design Professional in writing at least ten (10) days prior to the bid opening. If there are any such conflicts, inconsistencies, errors or omissions in the Contract Documents, the Bidder (i) will provide the labor, equipment or materials of the better quality or greater quantity of Work; and/or (ii) will comply with the more stringent requirements. The Bidder will not be entitled to any Change Order, additional compensation or additional time for any conflicts, inconsistencies, errors or omissions that would have been discovered by such careful and diligent review, unless it has given such prior written notice to Design Professional.
- 3. The Bidder represents that it has had a competent person carefully and diligently inspect and examine the entire site for the Project and the surrounding area, including all parts of the site applicable to the Work for which it is submitting its bid, and carefully correlate the results of the inspection with the requirements of the Contract Documents. The Bidder agrees that its bid shall include all costs attributable to site and surrounding area conditions that would have been discovered by such careful and diligent inspection and examination of the site and the

surrounding area, and the Bidder shall not be entitled to any Change Order, additional compensation, or additional time on account of conditions that could have been discovered by such an investigation.

4. The Bidder represents, understands and agrees that a) the Claim procedures in the Modified General Conditions are material terms of the Contract Documents, b) if it has a Claim, it will have its personnel provide complete and accurate information to complete and submit the Statement of Claim form on a timely basis, c) the proper completion and timely submission of a Statement of Claim form is a condition precedent to any change in the Contract Sum or the Contract Time(s), and d) the proper and timely submission of the Statement of Claim form provides the Owner and the Design Professional with necessary information so that the Owner may investigate the Claim and mitigate its damages.
5. The Bidder represents that the bid contains the name of every person interested therein and is based upon the Standards specified by the Contract Documents.
6. The Bidder and each person signing on behalf of the Bidder certifies, and in the case of a bid by joint venture, each member thereof certifies as to such member's entity, under penalty of perjury, that to the best of the undersigned's knowledge and belief: (a) the Base Bid, any Unit Prices and any Alternate bid in the bid have been arrived at independently without collusion, consultation, communication or agreement, or for the purpose of restricting competition as to any matter relating to such Base Bid, Unit Prices or Alternate bid with any other Bidder; (b) unless otherwise required by law, the Base Bid, any Unit Prices and any Alternate bid in the bid have not been knowingly disclosed by the Bidder and will not knowingly be disclosed by the Bidder prior to the bid opening, directly or indirectly, to any other Bidder who would have any interest in the Base Bid, Unit Prices or Alternate bid; (c) no attempt has been made or will be made by the Bidder to induce any other Person to submit or not to submit a bid for the purpose of restricting competition; and (d) the statements made in this Bid Form are true and correct.
7. The Bidder will execute the form of Owner/Contractor Agreement in the form included with the Contract Documents, if a Contract is awarded on the basis of this bid, and if the Bidder does not execute the Contract Form for any reason, other than as authorized by law, the Bidder and the Bidder's Surety are liable to the Owner.
8. The Bidder certifies that the upon the award of a Contract, the Contractor will ensure that all of the Contractor's employees, while working on the Project site, will not purchase, transfer, use or possess illegal drugs or alcohol or abuse prescription drugs in any way.
9. The Bidder agrees to furnish any information requested by the Design Professional or the Owner's authorized representative to evaluate that the Bidder has submitted the lowest responsible bid and that the bid is responsive to the specifications.
10. The Bidder certifies that it has no unresolved findings for recovery issued by the Auditor of State.
11. The Bidder certifies that it is aware of and in compliance with the requirements of Ohio Revised Code Section 3517.13 regarding campaign contributions.

LEGAL NAME OF BIDDER: _____

BIDDER IS (check one): ☐ sole proprietor ☐ partnership ☐ corporation ☐ other legal entity

NAME & TITLE OF PERSON LEGALLY AUTHORIZED TO BIND BIDDER TO A CONTRACT:

_____ Name	_____ Title
DATE SIGNED: _____	SIGNATURE: _____

ADDRESS: _____

TELEPHONE: _____

FAX: _____

FEDERAL TAX I.D. # _____

When the Bidder is a partnership or a joint venture, state name and address of each partner in the partnership or participant in the joint venture below:

Name

Address

Name

Address

Name

Address

Name

Address

Name

Address

END OF SECTION

BID FORM
FOR THE CONSTRUCTION OF
CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2

TO CITY OF MASSILLON

The undersigned hereby declares that he has carefully examined all Bidding and Contract Documents and that he has personally inspected the actual location of the Work, together with the local sources of supply, has satisfied himself as to all the quantities and conditions, and understand that in signing this Bid he waives all right to plead any misunderstanding regarding the same.

Pursuant to and in compliance with the Advertisement for bids and the Documents relating thereto, the Bidder hereby offers to furnish all plant, labor, materials, supplies, equipment and other facilities and things necessary or proper for, or incidental to the construction and completion of this Contract, as required by and in strict compliance with the applicable provisions of all Contract Documents, for the following unit and/or lump sum prices.

The undersigned further agrees to accept the unit prices, if any, set forth, as full payment for or the amount of credit to the Owner for, any deletions, additions, modifications or changes to the portion or portions of Work covered by said unit prices.

The undersigned agrees that the Work will be substantially complete and completed and ready for final payment in accordance with the Modified General Conditions and on or before the dates or within the number of calendar days indicated in the Owner-Contractor Agreement. The undersigned accepts the provisions of the Owner-Contractor Agreement as to liquidated and special damages in the event of failure to complete the Work within the Contract Times.

BID FORM
CITY OF MASSILLON, OH
2013 WWTP IMPROVEMENTS PROJECT

CONTRACT NO. 2

PAYMENT ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT OR LUMP SUM PRICE		TOTAL AMOUNT
			WORDS	FIGURES	
SECTION NO. 1 – LUMP SUM ITEMS					
1.1	Mobilization	Lump Sum	<u>FOUR HUNDRED</u> <u>THOUSAND</u> Dollars <u>ZERO</u> Cents LUMP SUM	\$ <u>400,000.00</u> LUMP SUM	\$ <u>400,000.00</u> TOTAL
1.2	City of Massillon WWTP Improvements Project – General. All Work included in the Contract, except Work included under PI 1.1, PI 3.1 thru PI 3.17, and PI 4.1.	Lump Sum	 Dollars Cents LUMP SUM	\$ LUMP SUM	\$ TOTAL
SECTION NO. 2 –BID ALTERNATE LUMP SUM ITEMS					
2.1	Not Applicable				

BID FORM
CITY OF MASSILLON, OH
2013 WWTP IMPROVEMENTS PROJECT

CONTRACT NO. 2

PAYMENT ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT OR LUMP SUM PRICE		TOTAL AMOUNT
			WORDS	FIGURES	
SECTION NO. 3 –UNIT PRICE ITEMS					
3.1	Sheeting and Shoring Left in Place	1,000 SF	Dollars Cents PER SF	\$ PER SF	\$ TOTAL
3.2	Excavation Below Subgrade	1,000 CY	Dollars Cents PER CY	\$ PER CY	\$ TOTAL
3.3	Test Pits	5 EA	Dollars Cents PER EA	\$ PER EA	\$ TOTAL

BID FORM

**CITY OF MASSILLON, OH
2013 WWTP IMPROVEMENTS PROJECT**

CONTRACT NO. 2

PAYMENT ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT OR LUMP SUM PRICE		TOTAL AMOUNT
			WORDS	FIGURES	
3.4	Erosion and Sediment Control, Silt Fencing	1,000 LF	Dollars Cents PER LF	\$ PER LF	\$ TOTAL
3.5	Erosion and Sediment Control, Sediment Trap	2 EA	Dollars Cents PER EA	\$ PER EA	\$ TOTAL
3.6	Erosion and Sediment Control, Temporary Diversion Dike	500 LF	Dollars Cents PER LF	\$ PER LF	\$ TOTAL

BID FORM

**CITY OF MASSILLON, OH
2013 WWTP IMPROVEMENTS PROJECT**

CONTRACT NO. 2

PAYMENT ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT OR LUMP SUM PRICE		TOTAL AMOUNT
			WORDS	FIGURES	
3.7	Full Depth Asphalt Paving	1,000 SY	Dollars Cents PER SY	\$ PER SY	\$ TOTAL
3.8	Concrete Sidewalk	100 SF	Dollars Cents PER SY	\$ PER SY	\$ TOTAL
3.9	Asphalt Pavement Plane and Resurface	500 SY	Dollars Cents PER SY	\$ PER SY	\$ TOTAL

BID FORM

**CITY OF MASSILLON, OH
2013 WWTP IMPROVEMENTS PROJECT**

CONTRACT NO. 2

PAYMENT ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT OR LUMP SUM PRICE		TOTAL AMOUNT
			WORDS	FIGURES	
3.10	Select Fill – Aggregate Base	250 CY	Dollars Cents PER CY	\$ PER CY	\$ TOTAL
3.11	Select Fill – Drainage Fill	500 CY	Dollars Cents PER CY	\$ PER CY	\$ TOTAL
3.12	Select Fill – Structural Fill	1000 CY	Dollars Cents PER CY	\$ PER CY	\$ TOTAL

BID FORM
CITY OF MASSILLON, OH
2013 WWTP IMPROVEMENTS PROJECT

CONTRACT NO. 2

PAYMENT ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT OR LUMP SUM PRICE		TOTAL AMOUNT
			WORDS	FIGURES	
3.13	Miscellaneous Form Work	1,000 SF	Dollars Cents PER SF	\$ PER SF	\$ TOTAL
3.14	Miscellaneous Reinforcement	1,000 LBS	Dollars Cents PER LB	\$ PER LB	\$ TOTAL
3.15	Miscellaneous Concrete (4,500 psi)	250 CY	Dollars Cents PER CY	\$ PER CY	\$ TOTAL
3.16	Concrete Surface Repair	250 SF	Dollars Cents PER SF	\$ PER SF	\$ TOTAL

BID FORM
CITY OF MASSILLON, OH
2013 WWTP IMPROVEMENTS PROJECT

CONTRACT NO. 2

PAYMENT ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT OR LUMP SUM PRICE		TOTAL AMOUNT
			WORDS	FIGURES	
3.17	Concrete Crack Repair	250 LF	Dollars Cents PER LF	\$ PER LF	\$ TOTAL
SECTION NO. 4 – ALLOWANCE ITEMS					
4.1	Laboratory Equipment	1 EA	FIFTY THOUSAND Dollars ZERO Cents PER EA	\$ 50,000.00 PER EA	\$ 50,000.00 TOTAL

BID FORM
CITY OF MASSILLON, OH
2013 WWTP IMPROVEMENTS PROJECT

CONTRACT NO. 2

SECTION NO. 5 – GRAND TOTAL BID		
	WORDS	FIGURES
<u>GRAND TOTAL BID</u> (INCLUDES PAYMENT ITEMS NO.: 1.1, 1.2, PI 3.1 thru PI 3.17, and PI 4.1.)		
		\$
		GRAND TOTAL
	Dollars	
	Cents	
	GRAND TOTAL	

Bidder understands that the award of the contract, if any, will be made on the basis of the grand total Bid amount without consideration of deducts for any substitutions. The grand total bid amount will be determined as the sum of the lump sum base bid, the lump sum alternate bid items, the products of the estimated quantity of each item and the unit price, and any allowance items.

Bidder understands that the lump sum base bid includes Payment Items No. 1.1 and No. 1.2 as stated above, as well as furnishing equipment and systems from the applicable manufacturers and suppliers named in this Bid Form for work under these payment items.

Bidder understands that the unit price items include Payment Items No. 3.1 thru 3.17 as stated above, and reflect work which is in addition to the work shown on the Contract Documents and may or may not be ordered by the Owner or Engineer. The Owner may, at their sole discretion, award any or none of the unit price items as part of the contract.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 1 - LUMP SUM ITEMS

PI-1.01. Description

Under this section, the Contractor shall furnish all materials and construct the structures and appurtenant facilities; shall furnish, install, test, place into satisfactory operation and maintain until final acceptance the equipment, piping and systems pertinent thereto; and shall fully complete the work of lump sum items, as shown, specified, scheduled and directed in the Contract Documents.

The principal items of work scheduled herein are included under this section. The work of this section also includes all accessories, appurtenances and other work required to complete this Contract, except those related to the work of these items but specifically included under other payment item sections of this Contract or under other contracts.

The schedules of the work which may be included have been shown solely for the convenience of the Owner, Engineer and Contractor, and do not necessarily include all of the items of work which are shown and specified and which are required under this Contract.

PI-1.02. Payment

Payment for the work of lump sum items will be made at the Contractor's lump sum prices stated in the Bid and appropriate to each item included under this section.

PI-1.03. No Payment

No payment will be made under this section for work performed by the Contractor to replace defective work, or for work which is not shown or ordered, or which is outside the limits shown or ordered.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 1 - LUMP SUM ITEMS

Item 1.1 - Mobilization

PI-1.1-01. Work Included

Work under this Item shall be comprised of set up of the necessary general plant, including shops, storage areas, office and such sanitary and other facilities as are required by local or state law or regulation. The cost of required insurance and bonds and any initiation of the Contract work is also included in this Item.

Item 1.2 – Massillon Ohio 2013 WWTP Improvements - General

PI-1.2-01. Description

Under this Item, the Contractor shall furnish all labor, materials and equipment required to construct, test, place into satisfactory operation, and maintain until final acceptance, Massillon Ohio 2013 WWTP Improvements - General, complete as shown, specified, scheduled or directed in the Contract Documents.

PI-1.2-02. Work Included

Work under this Item shall generally be comprised of, but not limited to, the following:

- Clearing;
- Erosion and sediment control measures
- Excavation (above the limiting subgrade), and disposal of excess excavated material;
- Sheeting and shoring as required;
- Dewatering as required;
- Demolition work and removal;
- Construction of structures, pads, buildings, and miscellaneous structures;
- Modifications to existing structures;
- Backfilling for structures, including select fill of granular materials under structures;
- Construction of all roads, walkways, guard rails, fencing and miscellaneous items;
- Furnishing, installing, testing, starting up, and placing into service the process systems;
- Yard piping;
- Surface restoration including grading and paving;
- Furnishing, installation, and testing of inside piping, valves, fittings, supports, and appurtenances;

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 1 - LUMP SUM ITEMS

- Furnishing, installation, and testing of all outside piping, including pipelines, manholes, valves, fittings, and appurtenances including trenching, granular materials, and backfill;
- Building in of sleeves, wall castings, concrete inserts for pipe and pipe supports and other items furnished under this Contract;
- Startup services, testing, and spare parts;
- Field painting;
- All mechanical, structural, electrical, control & instrumentation, HVAC, and plumbing work associated under this Contract;
- Miscellaneous items required to construct the Massillon WWTP Improvements Project, and not specifically included under other Payment Items;
- Contractor and subcontractor markups for overhead and profit.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

PI-3.01. Description

Under this section, the Contractor shall perform the unit price work ordered by the Engineer. All work under this section shall be done only upon specific direction of the Engineer and shall be only to the lines, grades and limits ordered.

The principal items of unit price work scheduled herein are included under this section. The work also includes all accessories, appurtenances or other work required for the completion of unit price items, except those related to the work of these items, but specifically included under other payment item sections of this Contract or other Contracts.

Prices for the unit items shall be written by the Contractor in the space provided in the bid sheets, and shall be extended by the given quantities. The unit price items reflect work which is in addition to the work shown in the Contract Documents and may or may not be ordered by the Owner or Engineer. Should such work be ordered by the Owner or Engineer, the Contractor shall make no claims whatsoever should the actual quantities of such work be different than the estimated quantities given in the bid sheets.

PI-3.02. Payment

Payment for the work of unit price items will be made at the Contractor's bid as stated in the Bid for each item included under this section.

PI-3.03. No Payment

No payment will be made under this section for work performed by the Contractor to replace defective work, work which is shown or specified, or which is outside the limits ordered. No payment will be made under this section for work related to the work of this section which is specifically included under other payment item sections.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.1 - Sheeting and Shoring Left in Place

PI-3.1-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Sheeting and Shoring Left in Place, as ordered by the Engineer.

PI-3.1-02. Work Included

Sheeting and shoring to be left in place for trench excavation and/or structural excavation for structures.

PI-3.1-03. Related Work Not Included

The following items of work closely related to Sheeting and Shoring Left in Place are specifically not included under this Item:

- Sheeting and Shoring which is shown or specified to be left in place
- Sheeting and Shoring Left in Place for work under other payment items

PI-3.1-04. Basis of Payment

The quantity of Sheeting and Shoring Left in Place for which payment will be made will be the actual number of square feet of Sheeting and Shoring Left in Place, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Sheeting and Shoring Left in Place which is specified elsewhere, herein, or not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.2 - Excavation Below Subgrade

PI-3.2-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Excavation Below Subgrade, as ordered by the Engineer.

PI-3.2-02. Work Included

Excavation Below Subgrade in areas of proposed structures or utilities, as directed by the Engineer.

PI-3.2-03. Related Work Not Included

The following items of work closely related to Excavation Below Subgrade are specifically not included under this Item:

- Excavation to the subgrade lines and limits for work in or at structures covered under other payment items

PI-3.2-04. Basis of Payment

The quantity of Excavation Below Subgrade for which payment will be made will be the actual number of cubic yards of Excavation Below Subgrade, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Excavation Below Subgrade which is not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.3 - Test Pits

PI-3.3-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Test Pits, as ordered by the Engineer.

PI-3.3-02. Work Included

Test Pits in various areas to determine depth and location of existing structures or utilities, as directed by the Engineer. For the purpose of the bid price, the Contractor shall assume to excavate and backfill a total of ten (10) cubic yards for each Test Pit, whether or not this number is actual.

PI-3.3-03. Related Work Not Included

The following items of work closely related to Test Pits are specifically not included under this Item:

- Structural excavation and trenching necessary to complete the work shown in the Contract Documents.
- Test pits for work covered under other payment items

PI-3.3-04. Basis of Payment

The quantity of Test Pits for which payment will be made in addition to the work shown in the Contract Documents will be the actual number of each Test Pit, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Test Pits which is specified elsewhere, herein, or not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.4 - Erosion and Sediment Control, Silt Fencing

PI-3.4-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Silt Fencing, as ordered by the Engineer.

PI-3.4-02. Work Included

Silt Fencing in various areas for sediment and erosion control, as directed by the Engineer.

PI-3.4-03. Related Work Not Included

The following items of work closely related to Silt Fencing are specifically not included under this Item:

- Other sediment erosion control measures as required by the Stark County Soil and Water Conservation District

PI-3.4-04. Basis of Payment

The quantity of Silt Fencing for which payment will be made will be the actual number of linear feet Silt Fencing, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Silt Fencing which is specified elsewhere, herein, or not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.5 - Erosion and Sediment Control, Sediment Trap

PI-3.5-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Sediment Trap, as ordered by the Engineer.

PI-3.5-02. Work Included

Sediment Trap in various areas for sediment and erosion control, as directed by the Engineer. Sediment Trap shall be sized for minimum 2 acres drainage area in accordance with the OEPA.

PI-3.5-03. Related Work Not Included

The following items of work closely related to Sediment Trap are specifically not included under this Item:

- Other sediment erosion control measures as required by the Stark County Soil and Water Conservation District

PI-3.5-04. Basis of Payment

The quantity of Sediment Trap for which payment will be made will be the actual number of Sediment Traps, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Sediment Trap which is specified elsewhere, herein, or not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.6 - Erosion and Sediment Control, Temporary Diversion Dike

PI-3.6-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Temporary Diversion Dike, as ordered by the Engineer.

PI-3.6-02. Work Included

Temporary Diversion Dike in various areas for sediment and erosion control, as directed by the Engineer.

PI-3.6-03. Related Work Not Included

The following items of work closely related to Temporary Diversion Dike are specifically not included under this Item:

- Other sediment erosion control measures as required by the Stark County Soil and Water Conservation District

PI-3.6-04. Basis of Payment

The quantity of Temporary Diversion Dike for which payment will be made will be the actual number of linear feet Temporary Diversion Dike, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Temporary Diversion Dike which is specified elsewhere, herein, or not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.7 – Full Depth Asphalt Pavement

PI-3.7-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Full Depth Asphalt Pavement, as ordered by the Engineer.

PI-3.7-02. Work Included

Full Depth Asphalt Pavement in various areas, as directed by the Engineer. Full Depth Asphalt Pavement shall be 15-inch thick section on prepared subgrade as indicated on the site/civil details.

PI-3.7-03. Basis of Payment

The quantity of Full Depth Asphalt Pavement for which payment will be made will be the actual number of square yards Full Depth Asphalt Pavement, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Full Depth Asphalt Pavement which is specified elsewhere, herein, or not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.8 – Concrete Sidewalk

PI-3.8-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Concrete Sidewalk, as ordered by the Engineer.

PI-3.8-02. Work Included

Concrete Sidewalk in various areas, as directed by the Engineer. Concrete Sidewalk shall be reinforced, 4-inch thick section on prepared subgrade as indicated on the site/civil details.

PI-3.8-03. Basis of Payment

The quantity of Concrete Sidewalk for which payment will be made will be the actual number of square feet Concrete Sidewalk, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Concrete Sidewalk which is specified elsewhere, herein, or not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.9 – Asphalt Pavement Plane and Resurface

PI-3.9-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Asphalt Pavement Plane and Resurface, as ordered by the Engineer.

PI-3.9-02. Work Included

Asphalt Pavement Plane & Resurface in various areas, as directed by the Engineer. Asphalt Pavement Plane & Resurface shall be 3-inch thick as indicated on the site/civil details.

PI-3.9-03. Basis of Payment

The quantity of Asphalt Pavement Plane & Resurface for which payment will be made will be the actual number of square yards Asphalt Pavement Plane & Resurface, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Asphalt Pavement Plane & Resurface which is specified elsewhere, herein, or not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.10 - Select Fill – Aggregate Base

PI-3.10-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Select Fill – Aggregate Base, as ordered by the Engineer.

PI-3.10-02. Work Included

Work under this Item shall generally be comprised of the following:

- The Contractor shall submit to the Engineer a sample of each granular material to be used, a sieve analysis and the location and Owner of borrow pit.

PI-3.10-03. Related Work Not Included

The following items of work closely related to Select Fill – Aggregate Base are specifically not included under this Item:

- Select Fill – **Drainage Fill and Structural Fill**
- Miscellaneous Concrete (4,500 psi)

PI-3.10-04. Basis of Payment

The quantity of Select Fill – Aggregate Base for which payment will be made will be the actual number of cubic yards of Select Fill – Aggregate Base performed, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Select Fill – Aggregate Base which is specified elsewhere, herein, or Select Fill – Aggregate Base not ordered by the Engineer

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.11 - Select Fill – Drainage Fill

PI-3.11-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Select Fill – Drainage Fill , as ordered by the Engineer.

PI-3.11-02. Work Included

Work under this Item shall generally be comprised of the following:

- The Contractor shall submit to the Engineer a sample of each granular material to be used, a sieve analysis and the location and Owner of borrow pit.

PI-3.11-03. Related Work Not Included

The following items of work closely related to Select Fill – Drainage Fill are specifically not included under this Item:

- Select Fill – Aggregate Base and Structural Fill
- Miscellaneous Concrete (4,500 psi)

PI-3.11-04. Basis of Payment

The quantity of Select Fill – Drainage Fill for which payment will be made will be the actual number of cubic yards of Select Fill – Drainage Fill performed, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Select Fill – Drainage Fill which is specified elsewhere, herein, or Select Fill – Drainage Fill not ordered by the Engineer

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.12 - Select Fill –Structural Fill

PI-3.12-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Select Fill –Structural Fill , as ordered by the Engineer.

PI-3.12-02. Work Included

Work under this Item shall generally be comprised of the following:

- The Contractor shall submit to the Engineer a sample of each granular material to be used, a sieve analysis and the location and Owner of borrow pit.

PI-3.12-03. Related Work Not Included

The following items of work closely related to Select Fill –Structural Fill are specifically not included under this Item:

- Select Fill – Aggregate Base and Drainage Fill
- Miscellaneous Concrete (4,500 psi)

PI-3.12-04. Basis of Payment

The quantity of Select Fill –Structural Fillfor which payment will be made will be the actual number of cubic yards of Select Fill –Structural Fillperformed, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Select Fill –Structural Fillwhich is specified elsewhere, herein, or Select Fill –Structural Fillnot ordered by the Engineer

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.13 - Miscellaneous Form Work

PI-3.13-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Miscellaneous Form Work, as ordered by the Engineer.

PI-3.13-02. Work Included

Work under this Item shall generally be comprised of the following:

- Miscellaneous form work for concrete placement

PI-3.13-03. Related Work Not Included

The following items of work closely related to Miscellaneous Form Work are specifically not included under this Item:

- Miscellaneous Excavation or Rock Removal.
- Miscellaneous Concrete (4,500 psi)

PI-3.13-04. Basis of Payment

The quantity of Miscellaneous Form Work for which payment will be made will be the actual number of square feet of Miscellaneous Form Work placed, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Miscellaneous Form Work which is specified elsewhere, herein, or Miscellaneous Form Work not ordered by the Engineer

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.14 - Miscellaneous Reinforcement

PI-3.14-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Miscellaneous Reinforcement, as ordered by the Engineer.

PI-3.14-02. Work Included

Work under this Item shall generally be comprised of the following:

- Miscellaneous reinforcement for concrete placement.

PI-3.14-03. Related Work Not Included

The following items of work closely related to Miscellaneous Reinforcement are specifically not included under this Item:

- Miscellaneous Concrete (4,500 psi)

PI-3.14-04. Basis of Payment

The quantity of Miscellaneous Reinforcement for which payment will be made will be the actual number of pounds of Miscellaneous Reinforcement placed, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Miscellaneous Form Work which is specified elsewhere, herein, or Miscellaneous Form Work not ordered by the Engineer

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.15 - Miscellaneous Concrete (4,500 psi)

PI-3.15-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Miscellaneous Concrete (4,500 psi), as ordered by the Engineer.

PI-3.15-02. Work Included

Work under this Item shall generally be comprised of the following:

- Concrete for cast in place structure bases, thrust blocks, anchor collars, and similar work.
- Concrete for miscellaneous use as directed by the Engineer.
- Reinforcing and all necessary form work.
- Excavation which is outside the payment limits shown or specified for structure or pipe installation, and excavation below subgrade, if necessary for installation of the concrete.
- Dewatering, as needed, of the additional excavation.
- Disposal of excess excavated material, including transporting, placing, grading, compaction, and seeding at Contractor's storage/disposal site, and including all transporting, placing, and disposal fees for excavated material taken to landfill facilities.
- All measures necessary to handle surface runoff and storm water flow within existing ditches, piping, or other areas including, but not limited to, bypass pumping or temporary rerouting.

PI-3.15-03. Related Work Not Included

The following items of work closely related to Miscellaneous Concrete (4,500 psi) are specifically not included under this Item:

- Concrete or cast-in-place concrete for work in or at structures covered under other payment items.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.15 - Miscellaneous Concrete (4,500 psi) (Continued)

PI-3.15-04. Basis of Payment

The quantity of Miscellaneous Concrete (4,500 psi) for which payment will be made will be the actual number of cubic yards of Miscellaneous Concrete (4,500 psi) installed, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Miscellaneous Concrete (4,500 psi) which is specified elsewhere, herein, or Miscellaneous Concrete (4,500 psi) not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.16 – Concrete Surface Repair

PI-3.16-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Concrete Surface Repair as ordered by the Engineer.

PI-3.16-02. Work Included

Work under this Item shall generally be comprised of the following:

- Repair of areas of spalled concrete within existing concrete walls, slabs, and elevated slabs within the WWTP

PI-3.16-03. Related Work Not Included

The following items of work closely related to Concrete Surface Repair are specifically not included under this Item:

- Concrete surface repairs for new concrete or at structures covered under other payment items.

PI-3.16-04. Basis of Payment

The quantity of Concrete Surface Repair for which payment will be made will be the actual number of feet of Concrete Surface Repair, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Concrete Surface Repair which is specified elsewhere, herein, or Concrete Surface Repair not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 3 - UNIT PRICE ITEMS

Item 3.17 – Concrete Crack Repair

PI-3.17-01. Description

Under this Item, the Contractor shall furnish all labor, materials, and equipment required to perform the work of Concrete Crack Repair as ordered by the Engineer.

PI-3.17-02. Work Included

Work under this Item shall generally be comprised of the following:

- Repair of existing concrete cracks not greater than 1” wide

PI-3.17-03. Related Work Not Included

The following items of work closely related to Concrete Crack Repair are specifically not included under this Item:

- Concrete crack repairs for new concrete or at structures covered under other payment items.

PI-3.17-04. Basis of Payment

The quantity of Concrete Crack Repair for which payment will be made will be the actual number of feet of Concrete Crack Repair, based on in-place measurement, as ordered by the Engineer.

No payment will be made under this item for the work of Concrete Crack Repair which is specified elsewhere, herein, or Concrete Crack Repair not ordered by the Engineer.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 4 – ALLOWANCE ITEMS

PI-4.01. Description

Under this section, the Contractor shall during the construction period furnish miscellaneous materials, equipment, furnishings and/or labor as directed by the Owner or Engineer under cash allowance items. The Owner reserves the right to partially or totally delete any or all cash allowance items. The Owner also reserves the right to purchase and have installed any or all materials, equipment or other furnishings directly from the supplier(s) or manufacturer(s) and not through the Contractor. The Contractor shall make no claim whatsoever should the actual cash amount authorized and paid to the Contractor be more or less than the cash allowance stated.

PI-4.02. Payment

Payment for cash allowance items will be made in accordance with the requirements specified in this section.

PI-4.03. No Payment

No payment will be made under this section for work performed by the Contractor to replace defective work. No payment will be made under this section for work related to the work of this section which is specifically included under other payment item sections.

CITY OF MASSILLON OHIO 2013 WWTP IMPROVEMENTS PROJECT
CONTRACT NO. 2 – GENERAL CONSTRUCTION

PAYMENT ITEMS
SECTION 4 – ALLOWANCE ITEMS

Item 4.1 – Laboratory Equipment

PI-4.1-01. Description

Under this Item the Contractor shall furnish, to the site, laboratory equipment for the lab in the Operations Building.

PI-4.1-02. Work Included

Laboratory equipment shall be furnished under this Item. Final catalog model numbers shall be confirmed with the Owner/Engineer during the construction period to allow the Owner to obtain the most current equipment commercially available. The Contractor's warranty as specified elsewhere in the Contract Documents shall apply to all items furnished under this bid Item.

PI-4.1-03. Related Work Not Included

The Contractor acknowledges that the installation, configuration, testing and demonstration work specified for the laboratory equipment purchased under this Item is included under Bid Item 1.2. The Contractor acknowledges that the Contract consideration for Bid Item 1.2 includes such sums for expenses and profit on account of the cash allowance as he deems proper, and that he shall make no claim for expenses or profit or any percentage override in addition thereto; said items having been considered and included under lump sum Bid Item 1.2.

PI-4.1-04. Basis of Payment

Payment will be made based on the actual amount authorized and spent for the cash allowance Item, as evidenced by invoices for the purchase and delivery of the materials and equipment to the job site.

No payment will be made under this cash allowance Item which is not ordered by the Owner or Engineer.

**BID GUARANTY AND
CONTRACT BOND**
(O.R.C. § 153.571)

KNOW ALL PERSONS BY THESE PRESENTS, that we, the undersigned _____
_____ ("Contractor") as principal and _____
_____ as surety are hereby held and firmly bound unto the **City of Massillon, Ohio**, as obligee in the penal sum of the dollar amount of the bid submitted by the principal to the obligee on _____, 20__, to undertake the construction of the **2013 WWTP Improvements Project - Contract No. 2, General Construction** ("Project"). The penal sum referred to herein shall be the dollar amount of the principal's bid to the obligee, incorporating any additive or deductive Alternates made by the principal on the date referred to above to the obligee, which are accepted by the obligee. In no case shall the penal sum exceed the amount of _____ Dollars (\$ _____). (If the foregoing blank is not filled in, the penal sum will be the full amount of the principal's bid, including any add Alternates. Alternatively, if the blank is filled in the amount stated must not be less than the full amount of the bid including add Alternates, in dollars and cents. A percentage is not acceptable.) For the payment of the penal sum well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors, and assigns.

Signed this _____ day of _____, 20__.

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH that whereas the above named principal has submitted a bid for work on the Project.

Now, therefore, if the obligee accepts the bid of the principal and the principal fails to enter into a proper contract in accordance with the bid, plans, details, specifications, and bills of material; and in the event the principal pays to the obligee the difference not to exceed ten percent (10%) of the penalty hereof between the amount specified in the bid and such larger amount for which the obligee may in good faith contract with the next lowest bidder to perform the work covered by the bid; or in the event the obligee does not award the contract to the next lowest bidder and resubmits the project for bidding, the principal pays to the obligee the difference not-to-exceed ten percent (10%) of the penalty hereof between the amount specified in the bid, or the costs, in connection with the resubmission, of printing new contract documents, required advertising, and printing and mailing notices to prospective bidders, whichever is less, then this obligation shall be null and void, otherwise to remain in full force and effect; if the obligee accepts the bid of the principal and the principal within ten (10) days after the awarding of the contract enters into a proper contract in accordance with the bid, plans, details, specifications, and bills of material, which said contract is made a part of this bond the same as though set forth herein.

Now also, if the said principal shall well and faithfully do and perform the things agreed by said principal to be done and performed according to the terms of said contract; and shall pay all lawful claims of subcontractors, materialmen, and laborers, for labor performed and materials furnished in the carrying forward, performing, or completing of said contract; we agreeing and assenting that this undertaking shall be for the benefit of any materialman or laborer having a just claim, as well as for the obligee herein; then this obligation shall be void; otherwise the same shall remain in full force and effect; and surety shall indemnify the obligee against all damage suffered by failure of the principal to perform the contract according to its provisions and in accordance with the plans, details, specifications, and bills of material therefor and to pay all lawful claims of subcontractors, materialmen, and laborers for labor performed or material furnished in carrying forward, performing, or completing the contract and surety further agrees and assents that this undertaking is for the benefit of any subcontractor, materialman, or laborer having a just claim, as well as for the obligee; it being expressly understood and agreed that the liability of the surety for any and all claims hereunder shall in no event exceed the penal amount of this obligation as herein stated.

The said surety hereby stipulates and agrees that no modifications, omissions, or additions in or to the terms of the said contract or in or to the plans or specifications therefore shall in any wise affect the obligations of said surety on its bond, and does hereby waive notice of any such modifications, omissions or additions to the terms of the contract or to the work or to the specifications.

Signed and sealed this _____ day of _____, 20__.

PRINCIPAL

By: _____

Printed Name & Title: _____

SURETY

By: _____

Printed Name & Title: _____

Surety's Address: _____

Surety's Telephone Number: _____

Surety's Fax Number: _____

SURETY'S AGENT

Surety's Agent's Address: _____

Surety's Agent's Telephone Number: _____

Surety's Agent's Fax Number: _____

NOTE: The Contract Bond form that follows is to be used ONLY by a bidder that is awarded a contract and submits a form of bid guaranty other than the combined Bid Guaranty and Contract Bond with its bid. If a bidder submits a combined Bid Guaranty and Contract Bond, then the bid guaranty becomes the contract bond when the contract is awarded.

AIA Bid Bond or Payment and Performance Bond forms are not acceptable for this Project.

CONTRACT BOND
(O.R.C. § 153.57)

KNOW ALL PERSONS BY THESE PRESENTS, that we, the undersigned ("Contractor"), as principal, and _____, as surety, are hereby held and firmly bound unto the **City of Massillon, Ohio** ("Owner") as obligee, in the penal sum of _____ Dollars (\$ _____), for the payment of which well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors, and assigns.

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH that whereas, the above-named principal did on the _____ day of _____, 20____, enter into a contract with the Owner for construction of the **2013 WWTP Improvements Project - Contract No. 2, General Construction** ("Project"), which said contract is made a part of this bond the same as though set forth herein:

Now, if the said Contractor shall well and faithfully do and perform the things agreed by the Contractor to be done and performed according to the terms of said contract; and shall pay all lawful claims of subcontractors, materialmen, and laborers, for labor performed and materials furnished in the carrying forward, performing, or completing of said contract; we agreeing and assenting that this undertaking shall be for the benefit of any materialman or laborer having a just claim, as well as for the obligee herein; then this obligation shall be void; otherwise the same shall remain in full force and effect; it being expressly understood and agreed that the liability of the surety for any and all claims hereunder shall in no event exceed the penal amount of this obligation as herein stated.

The said surety hereby stipulates and agrees that no modifications, omissions, or additions in or to the terms of the said contract or in or to the plans or specifications therefore shall in any wise affect the obligations of said surety on its bond, and does hereby waive notice of any such modifications, omissions or additions to the terms of the contract or to the work or to the specifications.

Signed and sealed this _____ day of _____, 20____.

(PRINCIPAL)

(SURETY)

By: _____

By: _____

Printed Name & Title: _____

Printed Name & Title: _____

Surety's Address: _____

Surety's Telephone Number: _____

Surety's Fax Number: _____

NAME OF SURETY'S AGENT

Surety's Agent's Address: _____

Surety's Agent's Telephone Number: _____

Surety's Agent's Fax Number: _____

CONTRACTOR'S QUALIFICATION STATEMENT
2013 WWTP Improvements Project -
Contract No. 2, General Construction

SUBMITTED TO: The City of Massillon
Attn: Joel Smith, Director of Public Service and Safety
151 Lincoln Way East
Massillon, OH 44646

SUBMITTED BY: _____

NAME: _____

ADDRESS: _____

PRINCIPAL OFFICE: _____

- ☐ Corporation
- ☐ Partnership
- ☐ Individual
- ☐ Joint Venture
- ☐ Other

NAME OF PROJECT: 2013 WWTP Improvements Project - Contract No. 2, General Construction
WPCLF # CS390580-0013

1. ORGANIZATION

- 1.1 How many years has your organization been in business as a Contractor in the construction industry?
- 1.2 How many years has your organization been in business under its present business name?
- 1.2.1 Under what other or former names has your organization operated?
- 1.3 If your organization is a corporation, answer the following:
- 1.3.1 Date of incorporation:
- 1.3.2 State of incorporation:
- 1.3.3 President's name:
- 1.3.4 Vice President's name(s):
- 1.3.5 Secretary's name:

- 1.3.6 Treasurer's name:
- 1.4 If your organization is a partnership, answer the following:
 - 1.4.1 Date of organization:
 - 1.4.2 Type of partnership (if applicable):
 - 1.4.3 Name(s) of general partner(s):
- 1.5 If your organization is individually owned, answer the following:
 - 1.5.1 Date of organization:
 - 1.5.2 Name of owner:
- 1.6 If the form of your organization is other than those listed above, describe it and name the principals:

2. LICENSING

- 2.1. List jurisdictions and trade categories in which your organization is legally qualified to do business, and indicate registration or license numbers, if applicable.
- 2.2. List jurisdictions in which your organization's partnership or trade name is filed.
- 2.3. List any suspension or revocations of any professional license of any director, officer, owner, or managerial employees of the Contractor, to the extent that any work to be performed on this Project is within the field of such licensed profession.

3. EXPERIENCE

- 3.1. List the categories of work that your organization normally performs with its own forces.
- 3.2. Claims and Lawsuits (If the answer to any of the questions below is yes, please attach details.)
 - 3.2.1. Has your organization ever failed to complete any work?
 - 3.2.2. Has your organization ever failed to complete any work by the substantial completion date, final completion date, or in a timely manner?
 - 3.2.3. Within the last five (5) years has your organization or any of its officers prosecuted any Claims, had any Claims prosecuted against it or them, or been involved in or is currently involved in any mediation or arbitration proceedings or lawsuits related to any construction project, or has any judgments or awards outstanding against it or them? Has your organization had any extension requests, fines and penalties imposed, or contract defaults? If the answer is yes, please attach the details for each Claim, including the names and telephone numbers of the persons who are parties, the amount of the Claim, the type of Claim and the basis for the Claim, and the outcome.

Note: As used in this document "Claim" means a Claim initiated under the Contract Documents for a project or relating to the Work for a project, including Claims made against performance bonds secured by the Contractor on other construction projects.

- 3.3. Has your organization ever failed to comply with federal, state, and local laws, rules, and regulations, including but not limited to the Occupational Safety and Health Act, the Ohio Prevailing Wage laws, and Ohio ethics laws? If the answer is yes, please attach details and reason(s) for each instance and the outcome including any fines or penalties imposed.
- 3.4. Within the last five years, has any officer or principal of your organization ever been an officer or principal of another organization when it failed to complete a construction contract? If the answer is yes, please attach details for each instance, including the

names and telephone numbers of the persons who are parties to the contract, and the reason(s) the contract was not completed.

- 3.5. On a separate sheet, list construction projects your organization has in progress with an original Contract Sum of more than \$10,000,000, giving the name of project, owner and its telephone number, design professional and its telephone number, contract amount, percent complete and scheduled completion date.

3.5.1. State total amount of work in progress and under contract:

- 3.6. Provide the following information for each contract your organization has had during the last five (5) years, including current contracts, where the Contract Sum is fifty percent (50%) or more of the bid amount for this Project, including add alternates. Include details regarding timeliness of performance and quality of work. List the original contract price for each project, the amount of any change orders or cost overruns on each, the reasons for the change orders or cost overruns, and your organization's record for complying with and meeting completion deadlines on construction projects. If there are more than ten (10) of these contracts, only provide information on the most recent ten (10) contracts, including current contracts.

Project And Work	Contract Sum	Owner's Representative & Telephone Number	Engineer's Or Architect's Representative Name & Telephone Number	Additional Comments

- 3.7. Provide the following information for each project your organization has had during the last five (5) years, which your organization believes is of comparable or greater size and complexity than the Owner's project. Include details regarding how such projects demonstrate your organization's ability and capacity to perform a substantial portion of the Project with its own work force. If there are more than five (5) of these projects, only provide information on the most recent five (5) projects, including current projects.

Project And Work	Contract Sum	Owner's Representative & Telephone Number	Engineer's Or Architect's Representative Name & Telephone Number	Additional Comments

- 3.7.1. State average annual amount of construction work your organization has performed during the last five years.
- 3.7.2. If any of the following members of your organization's management -- president, chairman of the board, or any director -- operates or has operated another construction company during the last five (5) years, identify the member of management and the name of the construction company.
- 3.7.3. If your organization is operating under a trade name registration with the Secretary of State for the State of Ohio, identify the entity for which the trade name is registered. If none, state "none."
- 3.7.4. If your organization is a division or wholly-owned subsidiary of another entity or has another relationship with another entity, identify the entity of which it is a division or wholly-owned subsidiary or with which it has another relationship and also identify the nature of the relationship. If none, state "not applicable."
- 3.8. On a separate sheet, list the construction education, training, construction experience, and tenure with your organization for each person who will fill a management role on the Project, including without limitation the Project Executive, Project Engineer, Project Manager, and Project Superintendent. For each person listed, include with the other information the last three projects on which the person worked and the name and telephone number of the Design Professional and the Owner.
- 3.9. Describe the size and experience of your organization's work force and your equipment and facilities, in relation to your organization's ability to complete the Project successfully and on time.

4. REFERENCES

- 4.1. Trade References:
- 4.2. Bank References:
- 4.3. Surety:
- 4.3.1. Name of bonding company:
- 4.3.2. Name and address of agent:

5. FINANCING

5.1 Financial Statement

- 5.1.1 Attach a financial statement, preferably audited, including your organization's latest balance sheet and income statement showing the following items:

Current Assets (e.g., cash, joint venture accounts, accounts receivable, notes receivable, accrued income, deposits, materials inventory and prepaid expenses);

Net Fixed Assets;

Other Assets;

Current Liabilities (e.g., accounts payable, notes payable, accrued expenses, provision for income taxes, advances, accrued salaries and accrued payroll taxes); and

Other Liabilities (e.g., capital, capital stock, authorized and outstanding shares par values, earned surplus and retained earnings).

- 5.1.2 Name and address of firm preparing attached financial statement, and date thereof.

- 5.1.3 Is the attached financial statement for the identical organization named on page one?

- 5.1.4 If not, explain the relationship and financial responsibility of the organization whose financial statement is provided (e.g., parent-subsidiary).

- 5.2 Will the organization whose financial statement is attached act as guarantor of the contract for construction?

- 5.3 Attach additional documentation or explanations demonstrating your organization's financial responsibility, adequate resources and availability of credit, its means and ability to procure insurance and acceptable performance bonds required for the Project.

6. Does your organization participate in a drug-free workplace program? Provide your organization's record for both resolved and unresolved findings of the Auditor of the State of Ohio for recovery as defined in Section 9.24 of the Ohio Revised Code.
7. List any projects within the previous five years where a public entity determined that your organization was not a responsible bidder, including the name of the public entity, the reasons given by the public entity, and an explanation thereof.

[left intentionally blank]

Certification. The undersigned certifies for the reliance of the Owner that after diligent investigation, to the best of the undersigned's belief, the information provided with this Contractor's Qualification Statement is true, accurate and not misleading.

SIGNATURE:

Dated this ____ day of _____ 20__.

Name of
Organization: _____

By: _____
[print name]

Signature: _____

Title: _____

State of _____

County of _____

_____, being duly sworn, deposes and says that the information provided herein is true and sufficiently complete so as not to be misleading.

Subscribed and sworn before me this ____ day of _____ 20__.

Notary Public

My Commission Expires: _____

SEAL

OWNER-CONTRACTOR AGREEMENT

OWNER:	<u>THE CITY OF MASSILLON</u>	CONTRACT:	<u>GENERAL CONTRACTOR</u>
ADDRESS:	<u>151 LINCOLN WAY EAST</u> <u>MASSILLON, OH 44646</u>	ALTERNATES:	_____
PROJECT:	<u>2013 WWTP IMPROVEMENTS</u> <u>PROJECT - CONTRACT NO. 2,</u> <u>GENERAL CONSTRUCTION</u>	CONTRACTOR:	_____
		ADDRESS:	_____ _____

This document is an agreement between the Owner and the Contractor for the Work described in the Contract Documents related to the Contract identified above for the Project defined above and is effective as of the date the Agreement is signed by the Owner.

The Owner and the Contractor agree as set forth in the following sections:

1. CONTRACT DOCUMENTS. The Contract Documents consist of the following documents:
 - A. Legal Notice;
 - B. Instructions to Bidders;
 - C. Bid Form;
 - D. Owner-Contractor Agreement including:
 - E. General Conditions of the Contract for Construction (EJCDC C-700, 2002 edition), as modified;
 - F. Drawings titled *Massillon WWTP 2013 Improvements - Contract No. 2, General Construction* and dated September 23, 2015;
 - G. Specifications;
 - H. Addenda issued;
 - I. Contractor's Personal Property Tax Affidavit (O.R.C. 5719.042);
 - J. Statement of Claim Form; and
 - K. Modifications issued after the execution of the contract, including:
 - i. A written amendment to the Agreement signed by both parties;
 - ii. A Change Order;
 - iii. A Work Change Directive; or,
 - iv. A written order for a minor change of the Work issued by the Design Professional in accordance with the General Conditions; and
 - L. Contractor's Completed EEO Certification Form
 - M. Contractor's Completed Certification Regarding Debarment, Suspension, and Other Responsibility Matters
 - N. Contractor's Executed American Steel & Iron Acknowledgement

Note: Technical Data / Non-Contract Documents. The following are key documents comprised of technical data prepared by others and used by the Design Professional in preparing the Contract Documents. These are not Contract Documents. Copies of these documents are located in the Appendix to the Technical Specifications. The General Conditions, as modified, contain additional terms related to these documents.

Subsurface Investigation
Statement of Special Inspections

Digester Gas Testing Results

CONTRACT 1a - Integrated Fixed Film Activated Sludge (IFAS) Equipment Procurement

CONTRACT 1b – Vertical Turbine Solids Handling (VTSH) Pumps Equipment Procurement

2. DESIGN PROFESSIONAL RELATIONSHIP. The Contract Documents shall not be construed to create a contractual relationship of any kind between the Design Professional and the Contractor or any Subcontractor or Material Supplier to the Project. The Design Professional, however, shall be entitled to performance of the obligations of the Contractor intended for its benefit and to enforcement of such obligations, but nothing contained herein shall be deemed to give the Contractor or any third party any claim or right of action against the Design Professional that does not otherwise exist without regard to this Contract. The Contractor and its Subcontractors shall not be deemed to be beneficiaries of any of the acts or services of the Design Professional that are performed for the sole benefit of the Owner. The Contractor shall forward all communications to the Owner through the Design Professional and hereby acknowledges and agrees that any instructions, reviews, advice, approvals, orders, or directives that are rendered to it by the Design Professional are specifically authorized and directed by the Owner to the Contractor through the Design Professional acting on behalf of the Owner.

- 2.1 The Design Professional (also called the “Engineer”) is:

CTI - O'Brien & Gere JV
220 Market Ave. South, Suite 750
Canton, OH 44702
(330) 455-7733

The Design Professional's Representative is William A. Dorman, P.E.

3. TIME FOR COMPLETION AND PROJECT COORDINATION.

- 3.1 DATE FOR COMMENCEMENT. The date of commencement of the Work shall be the date that written Notice to Proceed is issued by the Owner, through the Design Professional, to the Contractor.
- 3.2 DATES FOR SUBSTANTIAL COMPLETION. The Project and Work for the Project consists of all labor, materials, equipment, and services necessary for overall construction of the Project, all in accordance with the Drawings and Specifications prepared by the Design Professional. The overall Project will be substantially complete within 791 calendar days of Owner's issuance of the Notice to Proceed.
- 3.2.1 Substantial Completion is the time at which the Work has progressed to the point where the Work is sufficiently complete, in accordance with the Contract Documents, so that the Work can be utilized for the purposes for which it is intended. Final Completion shall mean that the Work is complete in accordance with the Contract Documents and the Contractor has submitted to the Design Professional all documents required to be submitted to the Design Professional for final payment. A Claim is “Finally Resolved” when the claim process is complete and not subject to further proceedings.
- 3.2.2 SHUTDOWN DATES. Due to events scheduled by the Owner and/or other Owner considerations, Contractor will not be able to perform Work on the Project on the following dates (there are no shutdown dates if none listed):

Contractor's Construction Schedule for performing the Work shall account for Contractor not being able to perform Work on these dates and the contractual dates for Substantial Completion and Final Completion will not be changed due to Contractor not being able to perform Work on these dates.

- 3.3 **CONSTRUCTION SCHEDULE.** The Construction Schedule shall be developed by the Contractor as provided in the Contract Documents.
- 3.4 **LIQUIDATED DAMAGES.** If the Contractor does not have its Work on the Project Substantially Complete by the specified Date for Substantial Completion or Finally Complete within forty-five (45) days of achieving Substantial Completion, the Contractor shall pay the Owner (and the Owner may set off from sums coming due the Contractor) Liquidated Damages in the per diem amounts as set forth in the following tables, whichever may be applicable. "Contract Amount" of the Work will be determined by totaling the cost of all line items of Work, as set forth in the Schedule of Values.

LIQUIDATED DAMAGES FOR SUBSTANTIAL COMPLETION OF OVERALL PROJECT

<u>Original Contract Amount</u>	<u>Dollars Per Day</u>
\$1.00 to \$500,000.00	\$ 750.00
\$500,000.01 to \$2,000,000.00	\$ 1,000.00
\$2,000,000.01 to \$10,000,000.00	\$ 1,300.00
\$10,000,000.01 to \$50,000,000.00	\$ 2,000.00
\$50,000,000.01 and greater	\$ 2,500.00

LIQUIDATED DAMAGES FOR FINAL COMPLETION

<u>Original Contract Amount</u>	<u>Dollars Per Day</u>
\$1.00 to \$500,000.00	\$ 200.00
\$500,000.01 to \$2,000,000.00	\$ 250.00
\$2,000,000.01 to \$10,000,000.00	\$ 325.00
\$10,000,000.01 to \$50,000,000.00	\$ 500.00
\$50,000,000.01 and greater	\$ 625.00

Contractor acknowledges that such amounts of Liquidated Damages represent a reasonable estimate of the actual damages for loss of or interference with the intended use of the Project that the Owner would incur if the Contractor's Work is not Substantially Complete by its Date for Substantial Completion or Finally Complete by the required date for Final Completion.

4. **CONTRACT SUM (also called Contract Price).** The Contract Sum to be paid by the Owner to the Contractor, as provided herein, for the satisfactory performance and completion of the Work and all of the duties, obligations, and responsibilities of the Contractor under this Agreement and the other Contract Documents is [REDACTED] Dollars (\$ [REDACTED]), subject to adjustment as set forth in the Contract Documents. The Contract Sum includes all federal, state, county, municipal, and other taxes imposed by law, including but not limited to any sales, use, commercial activity, and personal property taxes payable by or levied against the Contractor on account of the Work or the materials incorporated into the Work. The Contractor will pay any such taxes. The Contract Sum includes the following:

Base Bid Amount: \$ [REDACTED] (Total of all Unit Price Extensions)

If after Substantial Completion of its Work, the Contractor fails to submit its final payment application with all the documents required to be submitted with such application within ninety

(90) days after written notice to do so from the Owner and without prejudice to any other rights and remedies the Owner may have available to it, the balance of the Contract Sum shall become the Owner's sole and exclusive property, and the Contractor shall have no further interest in or right to such balance.

5. **RETAINAGE.** Retainage applicable to the Contract by Ohio Revised Code Sections 153.12, .13, and .14 will be withheld as defined in the Modified General Conditions. The Contractor agrees that the financial institution selected by the Owner for deposit of retained funds is acceptable to the Contractor and will sign any documents requested related to said account.

6. **GENERAL.**

- 6.1 **MODIFICATION.** No modification or waiver of any of the terms of this Agreement or of any other Contract Documents will be effective against a party unless set forth in writing and signed by or on behalf of a party. In the case of the Owner, the person executing the modification or waiver must have express authority to execute the Modification on behalf of the Owner pursuant to a resolution that is duly adopted by the Owner. Under no circumstances will forbearance, including the failure or repeated failure to insist upon compliance with the terms of the Contract Documents, constitute the waiver or modification of any such terms. The parties acknowledge that no person has authority to modify this Agreement or the other Contract Documents or to waive any of its or their terms, except as expressly provided in this section.
- 6.2 **ASSIGNMENT.** The Contractor may not assign this Agreement without the written consent of the Owner, which the Owner may withhold in its sole discretion.
- 6.3 **LAW AND JURISDICTION.** All questions regarding the validity, intention, or meaning of this Agreement or any modifications of it relating to the rights and obligation of the parties will be construed and resolved under the laws of the State of Ohio. Any suit, which may be brought to enforce any provision of this Agreement or any remedy with respect hereto, shall be brought in the Common Pleas Court of Stark County, Ohio and each party hereby expressly consents to the exclusive jurisdiction of such court to the exclusion of any other court, including any U.S. District Court or any other federal court.
- 6.4 **CONSTRUCTION.** The parties acknowledge that each party has reviewed this Agreement and the other Contract Documents and entered into this Agreement as a free and voluntary act. Accordingly, the normal rule of construction to the effect that any ambiguities are to be resolved against the drafting party will not be employed in the interpretation of this Agreement, the other Contract Documents, or any amendments or exhibits to it or them.
- 6.5 **APPROVALS.** Except as expressly provided herein, the approvals and determinations of the Owner and Design Professional will be subject to the sole discretion of the respective party and be valid and binding on the Contractor, provided only that they be made in good faith, i.e., honestly. If the Contractor challenges any such approval or determination, the Contractor has the burden of proving that it was not made in good faith by clear and convincing evidence.
- 6.6 **PARTIAL INVALIDITY.** If any term or provision of this Agreement is found to be illegal, unenforceable, or in violation of any laws, statutes, ordinances, or regulations of any public authority having jurisdiction, then, notwithstanding such term or provision, this Agreement will remain in full force and effect and such term will be deemed stricken; provided this Agreement will be interpreted, when possible, so as to reflect the intentions of the parties as indicated by any such stricken term or provision.
- 6.7 **COMPLIANCE WITH LAWS AND REGULATIONS.** The Contractor, at its expense, will comply with all applicable federal, state, and local laws, rules, and regulations applicable to the Work, including but not limited to Sections 153.59 and 153.60 of the Ohio Revised

Code, which prohibit discrimination in the hiring and treatment of employees, with respect to which the Contractor agrees to comply and to require its subcontractors to comply.

6.7.1 NON-DISCRIMINATION. Contractor agrees:

- .1 That in the hiring of employees for the performance of Work under this Agreement or in any subcontract, neither the Contractor, subcontractor, or any person acting on behalf of either of them, shall by reason of race, creed, sex, disability as defined in Section 4112.01 of the Ohio Revised Code, or color discriminate against any citizen of the state in the employment of labor or workers who are qualified and available to perform the Work to which the employment relates.
- .2 That neither the Contractor, subcontractor, nor any person acting on behalf of either of them shall, in any manner, discriminate against or intimidate any employee hired for the performance of Work under this Agreement on account of race, creed, sex, disability as defined in Section 4112.01 of the Ohio Revised Code, or color.
- .3 That there shall be deducted from the amount payable to the Contractor by the Owner under this Agreement a forfeiture of twenty-five dollars (\$25.00) as required by Ohio Revised Code Section 153.60 for each person who is discriminated against or intimidated in violation of this Agreement.
- .4 That this Agreement may be canceled or terminated by the Owner and all money to become due hereunder may be forfeited for a second or subsequent violation of the terms of this section of this Agreement.

6.7.2 PREVAILING WAGE RATES.

FEDERAL PREVAILING WAGE RATES. The Contractor and its subcontractors, regardless of tier, shall strictly comply with their obligation to pay their employees working on the Project site at the applicable prevailing wage rates for the type of work, including any changes thereto, pursuant to 40 U.S.C 276a to 276 a-5, as amended (Davis-Bacon Act), using General Wage Decision No. OH150002 08/21/2015 OH2, which is included in the Project Manual.

The Contractor and its subcontractors, regardless of tier, shall strictly comply with all other obligations of the Davis-Bacon Act, and the Contract Work Hours and Safety Standards Act.

- .6.7.3 ETHICS. By signing and entering into this agreement with the Owner, the Contractor represents that it is familiar with all applicable ethics law requirements, including without limitation Sections 102.04 and 3517.13 of the Ohio Revised Code, and certifies that it is in compliance with such requirements. The Contractor understands that failure to comply with the ethics laws is, in itself, grounds for termination of this contract and may result in the loss of other contracts with the Owner.

6.7.4 CONTINUOUS TREATMENT.

Federal regulations prohibit by-passing of any sewage during construction operations. The Contractor will be responsible for providing any required temporary pumping facilities piping, etc., necessary to complete the project without any plant by-passing and continuous treatment must be provided at the same level during construction as existed prior to construction.

Unless otherwise previously or subsequently specified, the Contractor shall procure and pay for all permits, licenses, and approvals necessary for the execution of his Contract.

The Contractor shall comply with all laws, ordinances, rules, orders, and regulations relating to the performance of the work required to complete their Contract.

- 6.7.5 VIOLATING FACILITIES. Contractor agrees to comply with all applicable standards, orders, or requirements under Section 306 of the Clean Air Act, 42 USC 1857(h), Section 508 of the Clean Water Act, 33 USC 1368, Executive Order 11738, and EPA regulations, 40 CFR Part 32, which prohibits the use under non-exempt Federal contracts, grants, or loans of facilities included in the EPA List of Violating Facilities.
- 6.8 JOB MEETINGS. The Contractor or one of its representatives with authority to bind the Contractor will attend all job meetings. The Owner anticipates that job meetings will be scheduled on a weekly basis during construction or as needed. The Contractor will ensure that its Subcontractors also hold regular job meetings at which safety issues and job matters are discussed as these relate to the Work being performed. Job meetings include, but are not limited to, pre-construction meetings, weekly job meetings, weekly safety tool box meetings, and monthly safety meetings.
- 6.9 PROPERTY TAX AFFIDAVIT. The Contractor's affidavit given under Section 5719.024, Ohio Revised Code, is incorporated herein.
- 6.10 PARTNERING. Contractor agrees that it will participate, as part of the Contract Sum, in any partnering sessions scheduled by Owner.
- 6.11 ENTIRE AGREEMENT. This Agreement and the other Contract Documents constitute the entire agreement among the parties with respect to their subject matter and will supersede all prior and contemporaneous, oral or written, agreements, negotiations, communications, representations, and understandings with respect to such subject matter, and no person is justified in relying on such agreements, negotiations, communications, representations, or understandings.

IN WITNESS WHEREOF, the parties have caused this Agreement to be executed by their properly authorized representatives and agree that this Agreement is effective as of the date first set forth above.

Owner: City of Massillon, Ohio

Contractor:

By: _____

By: _____

Name: _____

Name: _____

Title: _____

Title: _____

Date: _____

Date: _____

CERTIFICATE

(Section 5705.41, R.C.)

The undersigned, fiscal officer of the Owner, certifies that the moneys required to pay that part of the Contract Sum coming due during the current fiscal year, under the Agreement to which this Certificate is attached have been lawfully appropriated for such purpose and are in the appropriate account of the Owner, or in the process of collection to the credit of the appropriate account or fund, free from any previous encumbrances. Moneys due in excess of the Contract Sum shall require an additional and separate Fiscal Officer's Certificate.

DATED: _____

Fiscal Officer

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the Controlling Law.

MODIFIED STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly By



PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
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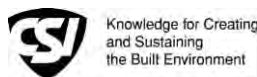
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These General Conditions have been prepared for use with the Suggested Forms of Agreement Between Owner and Contractor Nos. C-520 or C-525 (2002 Editions). Their provisions are interrelated and a change in one may necessitate a change in the other. Comments concerning their usage are contained in the EJCDC Construction Documents, General and Instructions (No. C-001) (2002 Edition). For guidance in the preparation of Supplementary Conditions, see Guide to the Preparation of Supplementary Conditions (No. C-800) (2002 Edition).

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GENERAL CONDITIONS

ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters or with all capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*--Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement or Owner-Contractor Agreement* -- The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.

3. *Application for Payment*--The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. *Asbestos*--Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

5. *Bid*--The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

6. *Bidder*--The individual or entity who submits a Bid directly to Owner.

7. *Bidding Documents*--The Bidding Requirements and the proposed Contract Documents (including all Addenda).

8. *Bidding Requirements*--The Advertisement or Invitation to Bid, Instructions to Bidders, bid security of acceptable form, if any, and the Bid Form with any supplements.

9. *Change Order*--A document recommended by Engineer which is signed by Contractor, and Owner and

authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

10. *Claim*--A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

11. *Contract*--The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. *Contract Documents*-- Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor's submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.

13. *Contract Price*--The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).

14. *Contract Times*--The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any, (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.

15. *Contractor*--The individual or entity with whom Owner has entered into the Agreement.

16. *Cost of the Work*--See Paragraph 11.01.A for definition.

17. *Drawings*--That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.

18. *Effective Date of the Agreement*--The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed by the Owner and delivered by the last of the two parties to sign and deliver.

19. *Engineer*--The individual or entity named as such in the Agreement.

20. *Field Order*--A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.

21. *General Requirements*--Sections of Division 1 of the Specifications. The General Requirements pertain to all sections of the Specifications.

22. *Hazardous Environmental Condition*--The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto in connection with the Work.

23. *Hazardous Waste*--The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

24. *Laws and Regulations; Laws or Regulations*--Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

25. *Liens*--Charges, security interests, or encumbrances upon Project funds, real property, or personal property.

26. *Milestone*--A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

27. *Notice of Award*. -- ~~A~~ The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.

28. *Notice to Proceed*--A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.

29. *Owner*--The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed. The Owner is the City of Massillon, Ohio.

30. *PCBs*--Polychlorinated biphenyls.

31. *Petroleum*--Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.

32. *Progress Schedule*--The Progress Schedule, sometimes called the Construction Schedule, is the document prepared by the Contractor. A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.

33. *Project*--The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.

34. *Project Manual*--The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.

35. *Radioactive Material*--Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

36. *Related Entity* -- An officer, director, partner, employee, agent, consultant, or subcontractor.

37. *Resident Project Representative*--The authorized representative of Engineer who may be assigned to the Site or any part thereof.

38. *Samples*--Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

39. *Schedule of Submittals*--A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.

40. *Schedule of Values*--A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

41. *Shop Drawings*--All drawings, diagrams, illustrations, schedules, and other data or information

which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

42. *Site*--Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.

43. *Specifications*--That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.

44. *Subcontractor*--An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

45. *Substantial Completion*--The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof. Substantial Completion is further defined as (i) that degree of completion of the Project's operating facilities or systems sufficient to provide Owner the full time, uninterrupted, and continuous beneficial operation of the Work; and (ii) all required functional, performance and acceptance or startup testing has been successfully demonstrated for all components, devices, equipment, and instrumentation and control to the satisfaction of Engineer in accordance with the requirements of the Specifications.

46. *Successful Bidder*--The Bidder submitting a responsive Bid to whom Owner makes an award.

47. *Supplementary Conditions*--That part of the Contract Documents which amends or supplements these General Conditions.

48. *Supplier*--A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or any Subcontractor.

49. *Underground Facilities*--All underground pipelines, conduits, ducts, cables, wires, manholes, vaults,

tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

50. *Unit Price Work*--Work to be paid for on the basis of unit prices.

51. *Work*--The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.

52. *Work Change Directive*--A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Engineer ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.02 Terminology

A. The following words or terms are not defined but, when used in the Bidding Requirements or Contract Documents, have the following meaning.

B. Intent of Certain Terms or Adjectives

1. The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action or determination will be solely to evaluate, in general, the Work for compliance with the requirements of and information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be

effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

C. Day

1. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

D. Defective

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:

- a. does not conform to the Contract Documents, or
- b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents, or
- c. has been damaged prior to Engineer’s - recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

E. Furnish, Install, Perform, Provide

1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

4. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.

F. Unless stated otherwise in the Contract Documents, words or phrases which have a well-known

technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 - PRELIMINARY MATTERS

2.01 Delivery of Bonds and Evidence of Insurance

~~A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds, insurance certificates, insurance endorsements, and other documents as Contractor may be required to furnish under the Contract Documents.~~

~~B. *Evidence of Insurance:* Before any Work at the Site is started, Contractor and Owner shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Contractor and Owner respectively are required to purchase and maintain in accordance with Article 5.~~
Evidence of Insurance: Before any Work at the Site is started, Contractor shall deliver to the Owner with copies to each additional insured identified in the Modified General Conditions Owner-approved copies of certificates of insurance, copies of endorsements, and other evidence of insurance which either of them or any additional insured may reasonably request, which Contractor is required to purchase and maintain in accordance with Article 5.

2.02 Copies of Documents

A. Owner shall furnish to Contractor up to ~~three~~ ~~ten printed~~ or hard copies of the Drawings and Project Manual. Additional copies will be furnished upon request at the cost of reproduction.

2.03 Commencement of Contract Times; Notice to Proceed

A. The Contract Times will commence to run in accordance with Section 3 of the Agreement~~on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.~~

2.04 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.

2.05 *Before Starting Construction*

A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:

1. ~~a preliminary Progress Schedule; indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;~~

2. a preliminary Schedule of Submittals; and

3. For lump sum work only, a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work. The total of the schedule of values prepared for the Work, as required by the General Conditions, shall not exceed the Bid submitted for the Work, unless such amount is adjusted as provided in the Contract Documents.

2.06 *Preconstruction Conference*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

2.07 *Initial Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be

made to Contractor until acceptable schedules are submitted to Engineer and Owner.

~~1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work nor interfere with or relieve Contractor from Contractor's full responsibility therefor.~~

1. The Construction/Progress Schedule shall be prepared as provided in the Contract Documents.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work. Once approved by the Engineer, the Contractor will not change the allocation of the Contract Price to the component parts of the Work without the Engineer's written approval. The Engineer thereafter may from time to time require the Contractor to adjust such schedule if the Engineer determines it to be in any way unreasonable or inaccurate. The Contractor then shall adjust the schedule of values as required by the Engineer within ten (10) days.

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result will be provided whether or not specifically called for at no additional cost to Owner.

C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

3.02 *Reference Standards*

A. Standards, Specifications, Codes, Laws, and Regulations

1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard, specification, manual or code, or any instruction of a Supplier shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, or Engineer, or any of, their Related Entities, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

A. Reporting Discrepancies

1. *Contractor's Review of Contract Documents Before Starting Work:* In addition to its obligations under the Instructions to Bidders, before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor may discover and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.

2. *Contractor's Review of Contract Documents During Performance of Work:* If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work or of any standard, specification, manual or code, or of any instruction of any Supplier, Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor knew or reasonably should have known thereof or Contractor failed to perform its obligations under the Instructions to Bidders.

4. In addition to its obligations under the Instructions to Bidders, if Contractor proceeds with work that Contractor had actual knowledge or should have known that a conflict, error, ambiguity, or discrepancy existed as indicated above, correction of work constructed without such notification to Engineer shall be at Contractor's expense, (except in an emergency as authorized by Paragraph 6.16.A.).

B. Resolving Discrepancies

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

a. the provisions of any standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Contract Documents); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

2. Within the Contract Documents, requirements of the Agreement shall take precedence over the Modified General Conditions, which shall take precedence over the Specifications, which shall take precedence over the Drawings.

3. Within a particular Contract Document, figure dimensions on Drawings shall take precedence over general Drawings. Specific instructions or specifications shall take precedence over general instructions or specifications.

3.04 *Amending and Supplementing Contract Documents*

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.

B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:

1. A Field Order;

2. Engineer's approval of a Shop Drawing or Sample; (Subject to the provisions of Paragraph 6.17.D.3); or

3. Engineer's written interpretation or clarification.

3.05 *Reuse of Documents*

A. Contractor and any Subcontractor or Supplier or other individual or entity performing or furnishing all of the Work under a direct or indirect contract with Contractor, shall not:

1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or Engineer's consultants, including electronic media editions; or

2. reuse any of such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adoption by Engineer.

B. The prohibition of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.06 *Electronic Data*

A. Copies of data furnished by Owner or Engineer to Contractor or Contractor to Owner or Engineer that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the

data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.

C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

ARTICLE 4 - AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS

4.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

~~B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which the Work is to be performed and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations. Upon reasonable request, Owner shall furnish Contractor with a Notice of Commencement prepared for the Project, conforming to the provisions of Ohio Revised Code Section 1311.252.~~

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.02 *Subsurface and Physical Conditions*

~~A. Reports and Drawings: The Supplementary Conditions identify Pages OCA-1 and OCA-2 of the Agreement identify:~~

1. those reports of explorations and tests of subsurface conditions at or contiguous to the Site that Engineer has used in preparing the Contract Documents; and

2. those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) that Engineer has used in preparing the Contract Documents.

3. it is possible that there may be other reports, and/or tests of subsurface conditions at or contiguous to the Site not prepared by or on behalf of Owner. The Owner makes no representation about such reports and/or tests, assuming they exist.

B. Limited Reliance by Contractor on Technical Data Authorized: Contractor may rely upon the general accuracy of the “technical data” contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such “technical data” is identified in ~~the Supplementary Conditions~~ the Agreement. Except for such reliance on such “technical data,” Contractor may not rely upon or make any claim against Owner or Engineer, or any of their Related Entities with respect to:

1. the completeness of such reports and drawings for Contractor’s purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any “technical data” or any such other data, interpretations, opinions, or information. For example, all interpolations and extrapolations of data performed by Contractor to estimate locations or quantities of subsurface strata are independent factual assumptions which Owner does not warrant.

4.03 Differing Subsurface or Physical Conditions

A. Notice: If Contractor believes that any subsurface or physical condition at or contiguous to the Site that is uncovered or revealed either:

1. is of such a nature as to establish that any “technical data” on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or

2. is of such a nature as to require a change in the Contract Documents; or

3. differs materially from that shown or indicated in the Contract Documents; or

4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents; then Contractor, as a condition precedent to any increase in the Contract Price and/or an extension of the Contract Times shall, ~~promptly~~ within 48 hours after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

B. Engineer’s Review: After receipt of written notice as required by Paragraph 4.03.A, Engineer will promptly review the pertinent condition, determine the necessity of Owner’s obtaining additional exploration or tests with respect thereto, and advise Owner in writing (with a copy to Contractor) of Engineer’s findings and conclusions.

C. Possible Price and Times Adjustments

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor’s cost of, or time required for, performance of the Work; subject, however, to the following:

a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and

b. with respect to Work that is paid for on a Unit Price Basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:

a. Contractor knew or should have known of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or

b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment; or

c. Contractor failed to give the written notice as required by Paragraph 4.03.A.

3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. ~~However, Owner and Engineer, and any of their Related Entities shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.~~

4.04 *Underground Facilities*

A. *Shown or Indicated:* The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, ~~including Owner~~, or by others. Unless it is otherwise expressly provided elsewhere in these Modified General Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data; and

2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:

~~a. reviewing and checking all such information and data;~~

~~ba. locating all Underground Facilities shown or indicated in the Contract Documents, protecting all Underground Facilities in a manner at least as cautious and protective of safety and of underground facilities as those methods identified in Ohio Revised Code Sections 3781.25 and 3781.30.~~

eb. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction, and

ec. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. *Not Shown or Indicated*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer. Engineer will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

2. If Engineer concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

4.05 *Reference Points*

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation

because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel. Contractor is referred to the General Requirements for additional requirements for laying out the work.

4.06 *Hazardous Environmental Condition at Site*

A. *Reports and Drawings:* Reference is made in the Agreement to the Supplementary Conditions for the identification of those reports and drawings relating to a Hazardous Environmental Condition identified at the Site, if any, that have been utilized by the Engineer in the preparation of the Contract Documents.

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the general accuracy of the “technical data” contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such “technical data” is identified in the Supplementary Conditions Owner-Contractor Agreement. Except for such reliance on such “technical data,” Contractor may not rely upon or make any claim against Owner or Engineer, or any of their Related Entities with respect to:

1. the completeness of such reports and drawings for Contractor’s purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any “technical data” or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.

D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous

Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any.

E. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered to Contractor written notice: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim therefor as provided in Paragraph 10.05.

F. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner’s own forces or others in accordance with Article 7.

~~G. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06. G shall obligate Owner to indemnify~~

~~any individual or entity from and against the consequences of that individual's or entity's own negligence.~~

HG. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

HH. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 5 - BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

~~A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents. Contractor shall furnish a Contract Bond in the amount of the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. Such bond shall be in the form that meets the requirements of the Ohio Revised Code. If the Contractor submitted a combined Bid Guaranty and Contract Bond with its bid for the Work, that form of Bond shall satisfy the Contractor's requirement to provide a Contract Bond. Contractor shall also furnish any other bonds as are required by the Contract Documents.~~

B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the

Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury and meet the other requirements of the Contract Documents. All bonds signed by an agent must be accompanied by a certified copy of the agent's authority to act.

C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

D. *Material Default or Termination.* If the Owner notifies the Contractor's surety that the Contractor is in material default, the surety will complete its investigation of the claimed material default within 21 days. The surety is advised to start looking for a replacement contractor upon notice of material default. As part of its investigation, the surety shall promptly visit the offices of the Contractor, Engineer, and Owner to inspect and copy the available Project records. The Owner, Engineer, and Contractor, upon written request by the surety, shall make such records available during regular business hours for such inspection and copying. The Owner and Engineer's making such records available as provided herein shall satisfy the Owner's obligation to the surety to furnish documents for the investigation. The surety will provide the Owner with the results of its investigation, including any written report or documents.

If the Owner terminates the Contract and the surety proposes to takeover the Work, the surety shall do so no later than the later of the expiration of the 21-day investigation period or 10 days after the date the Owner terminates the Contract, whichever is later. If the Owner terminates the Contract, and the surety proposes to provide a replacement contractor, the replacement contractor shall be fully capable of performing the Work in accordance with the Contract Documents. If the Contractor is terminated for cause, the replacement contractor shall not be the Contractor or a contractor comprised of mostly Contractor's employees, unless the Owner agrees in writing. In the event the Surety takes over the Project, the surety's obligation shall not be limited to the penal sum of the Bond.

If the surety does not propose an acceptable contractor as required by this Paragraph 5.01.D, the Owner may complete the Work by such means as it deems appropriate. In the event the Owner agrees to accept a replacement contractor, the replacement contractor shall furnish its own bond for the replacement

contractor's scope of work, and neither the Contractor nor the surety shall be relieved of their obligations under the Contract Documents.

This Paragraph 5.01.D is in addition to any other rights of the Owner under the Contract Documents and is not intended to create any rights of the surety, including but not limited to the right to take over the Contractor's obligations.

In the event of the Contractor's termination and if the surety does not takeover the Work as provided in this Paragraph 5.01.D., the Owner may take possession of and use all materials, facilities and equipment at the Project Site or stored off-site for which Owner has paid in whole or in part.

5.02 *Licensed Sureties and Insurers*

A. All bonds and insurance required by the Contract Documents to be purchased and maintained by Owner or Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Modified General Conditions.

5.03 *Certificates of Insurance*

~~A. Contractor shall deliver to Owner, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.~~ Contractor shall deliver to Owner, with copies to each additional insured identified in the Modified General Conditions, 3 certificates of insurance, copies of endorsements, or when specifically requested by the Owner, 3 certified copies of the insurance policies and a receipt evidencing full payment of the premiums, and other evidence of insurance requested by Owner or any other additional insured, which Contractor is required to purchase and maintain.

B. Owner shall deliver to Contractor, with copies to each additional insured identified in these ~~Supplementary~~ Modified General Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.

C. Failure of Owner to demand such certificates or other evidence of full compliance with these insurance requirements or failure of Owner to identify a deficiency from evidence provided shall not be construed as a waiver

of Contractor's obligation to maintain such insurance.

D. By requiring such insurance and insurance limits herein, Owner does not represent that coverage and limits will necessarily be adequate to protect Contractor, and such coverage and limits shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner in the Contract Documents.

5.04 *Contractor's Liability Insurance*

A. Contractor shall purchase and maintain such liability and other insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:

a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or

b. by any other person for any other reason;

5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and

6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

B. The policies of insurance required by this Paragraph 5.04 shall:

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, include as additional insured ~~(subject to any customary exclusion regarding professional liability)~~ Owner and Engineer, and any other individuals or entities identified in these ~~Supplementary~~ Modified General Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, partners, employees, agents, consultants and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

2. include at least the specific coverages and be written for not less than the limits of liability provided in ~~the Supplementary Conditions~~ Paragraph 5.04B.2.a or required by Laws or Regulations, whichever is greater;

a. The minimum limits of liability for the required insurance policies listed in Paragraph 5.04.A shall not be less than the following unless a greater amount is required by law:

- (1) Commercial General Liability ("CGL"); Bodily injury (including death and emotional distress) and property damage with limits of \$1,000,000 each occurrence and \$2,000,000 aggregate. CGL shall include (i) Premises-Operations, (ii) Explosion and Collapse Hazard, (iii) Underground Hazard, (iv) Independent Contractors' Protective, (v) Broad Form Property Damage, including Completed Operations, (vi) Contractual Liability, (vii) Products and Completed Operations, (viii) Personal/Advertising Injury (ix) Stopgap liability with Ohio Intentional Tort endorsement for \$1,000,000 limit, and (x) per project aggregate endorsement.
- (2) Automobile Liability, covering all owned, non-owned, and hired vehicles used in connection with the Work: Bodily injury (including death and emotional distress) and property damage with a combined single limit of \$1,000,000 per person and \$1,000,000 each accident.
- (3) Such policies shall be supplemented by an umbrella policy, also written on an occurrence basis, to provide additional protection to provide coverage in the total amount of \$1,000,000 for each occurrence

and \$1,000,000 aggregate for contracts with a Contract Price of \$250,000 or less; \$2,000,000 each occurrence and \$2,000,000 aggregate for contracts with a Contract Price greater than \$250,000 but less than or equal to \$500,000; \$3,000,000 each occurrence and \$3,000,000 aggregate for contracts with a Contract Price greater than \$500,000 but less than or equal to \$1,000,000; and \$5,000,000 each occurrence and \$5,000,000 aggregate for contracts with a Contract Price greater than \$1,000,000.

The following provisions shall also apply to the insurance provided by the Contractor:

- (a) Contractor's insurance shall be primary and non-contributory.
 - (b) Insurance policies shall be written on an occurrence basis only.
 - (c) The Contractor shall require all Subcontractors to provide Workers' Compensation, CGL, and Automobile Liability Insurance with the same minimum limits specified herein, unless the Owner agrees to a lesser amount.
 - (d) Owner shall be named as a certificate holder on the policies of insurance maintained by Contractor. The Contractor shall provide each additional insured with a certificate of insurance.
 - (e) The additional insured endorsement shall be ISO 20 10 10 01 and CG 2037 10 01 or their equivalents so that Completed Operations liability extends to the additional insureds after the completion of the Project.
3. include products and completed operations insurance;
4. include contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;
5. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed with respect to coverage for the Project or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the ~~Supplementary~~ Modified General Conditions to whom a certificate of insurance has been issued (and the certificates of

insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);

6. remain in effect at least until final payment and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and

7. with respect to ~~products and completed operations insurance, and any insurance coverage written on a claims-made basis,~~ remain in effect for at least two years after final payment.

a. Contractor shall furnish Owner and each other additional insured identified in these ~~Supplementary Modified General~~ Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

5.05 *Owner's Liability Insurance*

A. In addition to the insurance required to be provided by Contractor under Paragraph 5.04, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

5.06 *Property Insurance*

A. Unless otherwise provided in the ~~Contract Documents~~Supplementary Conditions, Owner shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Contract Documents ~~Supplementary Conditions~~ or required by Laws and Regulations). This insurance shall:

1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Contract Documents ~~Supplementary Conditions~~, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured;

2. be written on a Builder's Risk "all-risk" or open peril or special causes of loss policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, false work, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning,

extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage, (other than caused by flood) and such other perils or causes of loss as may be specifically required by the Contract Documents ~~Supplementary Conditions~~;

3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);

4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;

5. allow for partial utilization of the Work by Owner;

6. include testing and startup; and

7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other additional insured to whom a certificate of insurance has been issued.

B. Owner shall purchase and maintain such boiler and machinery insurance or additional property insurance as may be required by these ~~Supplementary Modified General~~ Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in these ~~Supplementary Modified General~~ Conditions, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured.

C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.

D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of Contractor, Subcontractors, or others in the Work to the extent of any

deductible amounts that are identified in the Contract Documents ~~Supplementary Conditions~~. The risk of loss within such identified deductible amount will be borne by Contractor, Subcontractors, or others suffering any such loss, and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

E. If Contractor requests in writing that other special insurance be included in the property insurance policies provided under Paragraph 5.06, Owner shall, if possible, include such insurance, and the cost thereof will be charged to Contractor by appropriate Change Order. Prior to commencement of the Work at the Site, Owner shall in writing advise Contractor whether or not such other insurance has been procured by Owner.

5.07 *Waiver of Rights*

A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in these ~~Supplementary~~ Modified General Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or additional insureds thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors, and Engineer, and all other individuals or entities identified in these ~~Supplementary~~ Modified General Conditions to be listed as insured or additional insured (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.

B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them for:

1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.

C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them.

5.08 *Receipt and Application of Insurance Proceeds*

A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Owner and made payable to Owner as fiduciary for the insureds, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.08.B. Owner shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order.

B. Owner as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to Owner's exercise of this power. If such objection be made, Owner as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, Owner as fiduciary shall adjust and settle the loss with the insurers. ~~and, if required in writing by any party in interest, Owner as fiduciary shall give bond for the proper performance of such duties.~~

5.09 *Acceptance of Bonds and Insurance; Option to Replace*

A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy. The property insurance shall contain no partial occupancy restriction for utilization of the Project by Owner.

ARTICLE 6 - CONTRACTOR'S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques,

sequences, and procedures of construction. Contractor shall not be responsible for the negligence of Owner or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances. The superintendent will be Contractor's representative at the Site and shall have authority to act on behalf of Contractor. All communications given to or received from the superintendent shall be binding on Contractor.

6.02 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.

B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, Shut Down Dates as defined in the Agreement, or any legal holiday without Owner's written consent (which will not be unreasonably withheld) given after prior written notice to Engineer. Contractor (and Subcontractor) regular working hours consist of 8 up to 10 working hours within an 11-hour period between 7:00 a.m. and 6:00 p.m., on a regularly scheduled basis, excluding Saturday, Sunday and holidays. Overtime work is work in excess of 40 hours per week.

6.03 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly

run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment. Contractor warrants that all materials and equipment for which Contractor has primary responsibility for choosing are suitable and fit for the intended use of such materials and equipment and are free from defects in material, workmanship or design. The foregoing applies whether the materials or equipment are specified in the Contract Documents.

C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

6.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Construction Schedule established in accordance with the Contract Documents. See Section 01320AIA of the Technical Specification titled "Construction Progress Documentation." ~~Paragraph 2.07 as it may be adjusted from time to time as provided below.~~

1. The Date for Substantial Completion shall only be changed or modified by Change Order, other Modification or a Claim that is Finally Resolved, regardless of the date in the Construction Schedule.

4. The float in the Construction Schedule and any updates to it shall belong to the Owner. Float shall mean the amount of time by which activities may be delayed without affecting the Contract Date for Substantial Completion.

2. The Contractor's obligation to furnish requested scheduling information is a material term of its Contract. If the Contractor fails to furnish requested scheduling information in writing within five (5) days of a request for such information from the Design Professional or Owner, the Contractor shall pay and the Owner may withhold from the Contractor Liquidated Damages at the rate of Fifty Dollars (\$50.00) a day for each calendar day thereafter that the Contractor fails to furnish the requested information.

~~Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.~~

~~2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be~~

~~submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.~~

B. THE PERIODS OF TIME IN THE PROJECT CONSTRUCTION SCHEDULE ARE OF THE ESSENCE TO THIS CONTRACT. THE CONTRACTOR SHALL PROSECUTE ITS WORK IN ACCORDANCE WITH THE CURRENT PROJECT CONSTRUCTION SCHEDULE.

1. Notice of Delays. As a condition precedent to any increase in the Contract Price and/or Contract Times, the Contractor shall give the Owner and the Engineer verbal notice of any delay affecting its Work within two (2) business days of the commencement of the delay. In addition and also as a condition precedent to any increase in the Contract Price and/or Contract Times, the Contractor shall give the Owner and Engineer written notice of the delay within ten (10) business days of the commencement of the delay with specific recommendations about how to minimize the effect of the delay. The written notice of the delay shall conspicuously state that it is a "NOTICE OF DELAY." A notice of a delay shall not constitute the submission of a Claim. Contract Times shall only be changed as provided in the Agreement. The Contractor acknowledges and agrees that these notice provisions are material terms of the Contract Documents and give the Owner the opportunity to take action to minimize the cost and/or effect of delays.

6.05 *Substitutes and "Or-Equals"*

A. ~~Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Substitutions prior to the receipt of bids shall be governed by the Instructions to Bidders. Substitutions after the entry into the Agreement shall be governed by these Modified General Conditions. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.~~

1. *"Or-Equal" Items:* If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items.

For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment Engineer determines that:

1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole,

3) it has a proven record of performance and availability of responsive service; and

b. Contractor certifies that, if approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times, and

2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

2. *Substitute Items*

a. If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.

b. Contractor shall submit sufficient information as provided below to allow Engineer to determine that the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.

c. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented in the General Requirements and as Engineer may decide is appropriate under the circumstances.

d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

1) shall certify that the proposed substitute item will:

a) perform adequately the functions and achieve the results called for by the general design,

b) be similar in substance to that specified, and

c) be suited to the same use as that specified;

2) will state:

a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time;

b) whether or not use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and

c) whether or not incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;

3) will identify:

a) all variations of the proposed substitute item from that specified, and

b) available engineering, sales, maintenance, repair, and replacement services;

4) and shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change,

B. Substitute Construction Methods or Procedures: If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that

the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.

C. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by either a Change Order for a substitute or an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.

D. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

E. *Engineer's Cost Reimbursement:* Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute item so proposed or submitted by Contractor, Contractor shall reimburse Owner for the charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

F. *Contractor's Expense:* Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

6.06 *Concerning Subcontractors, Suppliers, and Others*

A. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection. If Owner or Engineer after due investigations has reasonable objections to any proposed Subcontractor, Supplier, or other individual or entity, either may request Contractor submit an acceptable substitute without an increase in Contract Price.

B. If the Contract Documents ~~Supplementary Conditions~~ require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for review or acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Contract Documents ~~Supplementary Conditions~~, Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No review or acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:

1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity, nor

2. shall anything in the Contract Documents create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.

E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.

F. The divisions and sections of the Specifications and the identifications of any Drawings shall not

control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as an additional insured on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, and Engineer, and all other individuals or entities identified in these Supplementary Modified General Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of Owner or Engineer its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of

any invention, design, process, product, or device not specified in the Contract Documents.

6.08 *Permits*

~~A. Unless otherwise provided in the Supplementary Conditions Contract Documents, Contractor shall obtain and pay for all construction permits and licenses. Owner has obtained, or will obtain the following permits for the Project, as applicable:~~

Ohio EPA Permit to Install
Ohio EPA NPDES Permit

Contractor shall secure and pay for all other permits necessary to complete the Project.

~~Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.~~

6.09 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor's primary responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 Taxes

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

B. Materials purchased for use or consumption in connection with the proposed Work will be exempt from the State of Ohio Sales Tax, as provided in Section 5739.02 of the Ohio Revised Code, and also from the State of Ohio Use Tax, as provided in Section 5741.01 of the Ohio Revised Code. The Owner will provide the Contractor with a Construction Tax Exempt Certificate upon request, made through the Engineer.

C. Purchases by the Contractor of expendable items, such as form lumber, tools, oil, greases, fuel, or equipment rentals, are subject to the application of Ohio Sales or Use Taxes.

D. Contractor shall withhold any income taxes due to the City of Massillon for wages, salaries and commissions paid to its employees for work done under this Agreement and further agrees that any of its subcontractors shall, by the terms of its subcontract, be required to withhold any such income taxes due for work performed under this Agreement.

6.11 Use of Site and Other Areas

A. Limitation on Use of Site and Other Areas

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work. Contractor shall not enter upon nor use property not under Owner control until appropriate easements have been executed and a copy is on file on the Project.

2. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.

3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder ~~to the extent caused or alleged to have been caused~~ by or based upon Contractor's performance of the Work.

B. Removal of Debris During Performance of the Work: During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. Cleaning: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. Loading Structures: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 Record Documents

A. Contractor shall maintain in a safe place at the Site ~~one~~ two record ~~copy~~ copies of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction. These record documents together with all approved Samples and a counterpart of all approved Shop Drawings will be available to Engineer for reference. ~~Upon completion of the Work, these record documents, Samples, and Shop Drawings will be delivered to Engineer for Owner.~~ The Contractor shall deliver these record documents, samples, and shop drawings to the Engineer, no later than the date for Substantial Completion, for the Engineer's review and transmittal to Owner.

6.13 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. all persons on the Site or who may be affected by the Work;

2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

C. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer, or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

D. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 *Safety Representative*

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

B. Contractor shall keep at the Site at all times during the progress of the Work as required by law a competent person to comply with OSHA trenching and excavation requirements. The competent person shall be one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions that are unsanitary, hazardous or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

6.15 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

6.16 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 *Shop Drawings and Samples*

A. Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the acceptable Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.

1. Shop Drawings

a. Submit number of copies specified in the General Requirements.

b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions,

specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.

2. *Samples*: Contractor shall also submit Samples to Engineer for review and approval in accordance with the acceptable schedule of Shop Drawings and Sample submittals.

a. Submit number of Samples specified in the Specifications.

b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.

B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. Submittal Procedures

1. Before submitting each Shop Drawing or Sample, Contractor shall have determined and verified:

a. all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

b. the suitability of all materials with respect to intended use, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work;

c. all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto; and

d. shall also have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.

2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal.

3. With each submittal, Contractor shall give Engineer specific written notice of any variations, that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawing's or Sample Submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. Engineer's Review

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. Resubmittal Procedures

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than

the corrections called for by Engineer on previous submittals.

2. Contractor shall furnish required submittals with sufficient information and accuracy in order to obtain required approval of an item with no more than the number of submittal reviews specified in Paragraph 14.02.D.4 of these Modified General Conditions. Engineer will record time for review of subsequent submittals of Shop Drawings, samples or other items requiring approval and Contractor shall reimburse Owner for Engineer's charges for such time in accordance with Paragraph 14.02.D.4.

3. In the event that Contractor requests a substitution for a previously approved item, Contractor shall reimburse Owner for Engineer's charges for such time, unless the need for such substitution is beyond the control of Contractor.

6.18 *Continuing the Work*

A. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

6.19 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its Related Entities shall be entitled to rely on representation of Contractor's warranty and guarantee.

B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:

1. observations by Engineer;

2. recommendation by Engineer or payment by Owner of any progress or final payment;

3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. use or occupancy of the Work or any part thereof by Owner;

5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;

6. any inspection, test, or approval by others; or

7. any correction of defective Work by Owner.

D. Upon final payment, the Contractor must assign and transfer to Owner all guarantees, warranties and agreements from and with all contractors, subcontractors, vendors, suppliers, and manufacturers regarding their performance, quality of workmanship, or quality of materials supplied in connection with the work. Contractor represents and warrants that all such guarantees, warranties, and agreements will be in place and enforceable by the Owner in accordance with their terms. The Owner, however, will not assume through any assignment or transfer required under this subparagraph any of the Contractor's payment obligations to any entities."

6.20 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify, defend and hold harmless Owner and Engineer, and the officers, directors, partners, employees,

agents, consultants, and subcontractors of each and any of them, from and against all claims, (whether alleged or proven), demands, costs, losses, and damages, including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs, arising out of or relating to the Work or any breach of Contractor's obligations under the Contract Documents, including but not limited to the breach of any warranty provided in the Contract Documents.

B. In any and all claims against Owner or Engineer or any of their respective consultants, agents, officers, directors, partners, or employees by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

~~C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, partners, employees, agents, consultants and subcontractors arising out of:~~

~~1. the preparation or approval of, or the failure to prepare or approve, maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications or~~

~~2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.~~

6.21 *Delegation of Professional Design Services*

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.

B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and

Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 7 - OTHER WORK AT THE SITE

7.01 *Related Work at Site*

A. Owner may perform other work related to the Project at the Site with Owner's employees, or via other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:

1. written notice thereof will be given to Contractor prior to starting any such other work; and

2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.

B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner and Owner, if Owner is performing other work with

Owner's employees, proper and safe access to the Site, a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and shall properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering their work and will only cut or alter their work with the written consent of Engineer and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.

C. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

7.02 Coordination

A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the Owner will provide for the coordination of the work at the Site in the Contract Documents. ~~the following will be set forth in Supplementary Conditions:~~

~~1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;~~

~~2. the specific matters to be covered by such authority and responsibility will be itemized; and~~

~~3. the extent of such authority and responsibilities will be provided.~~

7.03 Legal Relationships

A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.

B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct

delay and disruption costs incurred by Contractor as a result of the other contractor's actions or inactions.

C. Contractor shall be liable to Owner and any other contractor for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's action or inactions.

7.04 Claims By Other Contractors

A. Should Contractor cause damage to the work or property of any separate contractor at the Site, or should any claim arising out of Contractor's performance of the Work at the Site be made by any other contractor against Contractor, Contractor shall promptly attempt to settle with such other contractor by agreement or to otherwise resolve the dispute by arbitration or at law.

B. Should Contractor cause damage to the work or property of any separate contractor at the Site, or should any claim arising out of Contractor's performance of the Work at the Site be made by any other contractor against Owner or Engineer, Contractor shall indemnify Owner and Engineer as required under Paragraph 6.20.

ARTICLE 8 - OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer or the resident Project Representative.

8.02 *Replacement of Engineer*

A. In case of termination of the employment of Engineer, Owner shall appoint an engineer, ~~to whom Contractor makes no reasonable objection,~~ whose status under the Contract Documents shall be that of the former Engineer.

8.03 *Furnish Data*

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

8.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.

8.05 *Lands and Easements; Reports and Tests*

A. Owner's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site that have been utilized by Engineer in preparing the Contract Documents.

8.06 *Insurance*

A. Owner's responsibilities, if any, in respect to purchasing and maintaining liability and property insurance are set forth in Article 5.

8.07 *Change Orders*

A. Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.

8.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility in respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

8.09 *Limitations on Owner's Responsibilities*

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

8.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.

8.11 *Evidence of Financial Arrangements*

A. If and to the extent Owner has agreed to furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents, Owner's responsibility in respect thereof will be as set forth in these Supplementary Modified General Conditions.

8.12 *Permits Obtained by Owner*

Owner will obtain and pay for the following construction permits and licenses, as applicable:

- Permit to Install from the Ohio EPA

A copy of each permit is available at Owner's office. Contractor shall examine the permits and conform to the requirements contained therein, and such requirements are hereby made part of these Contract Documents as though the same were set forth herein. Failure to examine the permit(s) will not relieve Contractor from compliance with the requirements stated therein.

ARTICLE 9 - ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract Documents and will not be changed without written consent of Owner and Engineer.

9.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques,

sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

A. ~~If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work and to assist in carrying out the Engineer's other responsibilities under the Contract Documents and its agreement with the Owner. The authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09.~~ If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual will be subject to the Contract Documents, specifically including the requirement in the Agreement that any Change Order or other Modification be authorized by a resolution duly adopted by the Owner, ~~or entity will be as provided in the Supplementary Conditions.~~

B. Resident Project Representative personnel on this project ~~may~~ will include personnel furnished by Owner, ~~Engineer, or both.~~ The duties and responsibilities of the Resident Project Representative(s) include the following:

1. Review schedules as required in Paragraph 2.05.A of the General Conditions and amendment thereto.
2. Attend conferences and meetings with Contractor.
3. Serve as liaison between Engineer and Contractor and help Engineer serve as liaison between Owner and Contractor.
4. Conduct on-site observation of the work.
5. Observe tests, equipment, and system startups.
6. Report to Engineer when clarifications and interpretations of the Contract Documents are needed. Consider, evaluate, and report to Engineer, Contractor's requests for modification.
7. Maintain orderly records, keep a daily log (when on a part-time basis, keep log for days visiting site), and furnish periodic reports to Engineer of the

progress of the Work.

8. Before project completion, prepare final list of items to be completed or corrected and make recommendations to Engineer concerning acceptance of the Work.

9. Review Payment Applications from Contractor.

The Resident Project Representatives shall not:

1. Authorize any deviation from the Contract Documents or substitutions of materials or equipment.
2. Exceed limitations of Engineer's authority as set forth in the Contract Documents.
3. Undertake any of the responsibilities of Contractor, Subcontractor, or Contractor's superintendent.
4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences, or procedures of construction.
5. Advise on, issue directions regarding, or assume control over safety precautions and programs in connection with the Work.
6. Accept shop drawing or sample submittals from anyone other than Contractor.
7. Authorize Owner to occupy the Project in whole or in part.
8. Participate in specialized field or laboratory tests or inspections conducted by others except as specifically authorized by Engineer.

9.04 *Authorized Variations in Work*

A. Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment,

a Claim may be made therefor as provided in Paragraph 10.05.

9.05 *Rejecting Defective Work*

A. Engineer will have authority to reject Work which Engineer believes to be defective, or that Engineer believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Engineer will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

9.06 *Shop Drawings, Change Orders and Payments*

A. In connection with Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.

B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.

C. In connection with Engineer's authority as to Change Orders, see Articles 10, 11, and 12.

D. In connection with Engineer's authority as to Applications for Payment, see Article 14.

9.07 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

B. Unit Price Work for which a typical cross section or other detail from the Contract Documents applies shall be paid only up to the quantity determined by using the dimensions provided in the typical cross section or other detail. By way of example, this provision means that if a typical trench width detail in the Drawings shows a maximum width of 30-inches, all pay quantities associated with the actual work of constructing the detail shall be calculated using a trench width not greater than 30-inches. This means that the actual pay quantity could

also be less than that based upon a 30-inch wide trench, if the actual trench width is smaller and otherwise in conformance with the Contract Documents, but the Contractor would not be paid more if the actual trench width exceeds 30 inches. Contractor is responsible for determining what actual trench width may be required due to field conditions and applicable laws and regulations existing at the time of its bid.

9.08 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within 30 days of the event giving rise to the question

B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believe that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.

D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.09 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to, the Resident Project Representative, if any, and assistants, if any.

ARTICLE 10 - CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by a Change Order, or a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided). The agreement on any Change Order shall constitute a final settlement of all matters relating to the change in the Work that is the subject of the Change Order, including, but not limited to, all direct, indirect and cumulative costs associated with such change and any and all adjustments to the Contract Sum and the Date for Substantial Completion.

B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change

Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.02 *Unauthorized Changes in the Work*

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.B.

10.03 *Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:

1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or Owner's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;

2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and

3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.04 *Notification to Surety*

A. If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times) is required by the provisions of any bond to be given to a surety, the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change. Failure to provide notice to the surety of any such change shall not exonerate the surety from its obligations under the bond.

10.05 Claims

A. *Engineer's Decision Required:* All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.

~~B. *Notice:* Written notice stating the general nature of each Claim, shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Time shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant's last submittal (unless Engineer allows additional time).~~
Notice: As a condition precedent to a change in the Contract Price or the Contract Times, for each Claim the Contractor shall deliver a fully completed Statement of Claim Form, a copy of which form is a Contract Document, to the Engineer and the Owner, within 21 days of the start of the underlying cause of the Claim. The Contractor shall be responsible for substantiating its Claim. The Contractor's failure to deliver a fully completed Statement of Claim form shall be an irrevocable waiver of Contractor's right to any form of additional compensation, be it in time or money, arising out of the Claim or the circumstances underlying the Claim. Further, the Contractor's obligation to deliver a fully completed Statement of Claim form within such 21 day period is a material term of the Contract Documents and provides the Owner with the opportunity to mitigate its damages.

C. *Engineer's Action:* Engineer will review each Claim and, within ~~30~~ 45 days after receipt of the ~~last submittal of the claimant or the last submittal of the opposing party, if any~~ Statement of Claim Form, take one of the following actions in writing:

1. deny the Claim in whole or in part,

2. approve the Claim, or

3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.

D. In the event that Engineer does not take action on a Claim within said ~~30~~ 45 days, the Claim shall be deemed denied.

~~E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.~~ Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor commences an action in a court of exclusive jurisdiction as set forth in Paragraph 16.01.A.2 within 30 days of substantial completion of the Work.

F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

G. *False or Fraudulent Claim.* The Contractor shall not knowingly present or cause to be presented to the Owner a false or fraudulent Claim. Knowingly shall have the same meaning as in Section 3729(b) USC of the Federal False Claims Act. If the Contractor knowingly presents or causes to be presented a false or fraudulent Claim, then the Contractor shall be liable to the Owner for the same civil penalty and damages as the United States Government would be entitled to recover under such Section 3729(a) USC and shall also indemnify and hold the Owner harmless from all costs and expenses, including Owner's attorneys' and consultants' fees and expenses incurred in investigating and defending against such Claim and in pursuing the collection of such penalty, damages and fees and expenses.

H. *Claim Documentation:* Within ten (10) days of written request from the Owner, Contractor shall make available to Owner or its representative any books, records, or other documents in its possession or to which it has access, including but not limited to Contractor's daily logs/reports, original estimates of Work and applicable agreements, correspondence with subcontractors and suppliers, internal correspondence (including e-mail), accounting records, and other information from which the Contractor's costs may be derived. To the extent permitted by law, the Owner shall

keep the Project accounting records and estimate for the Project confidential. As requested by the Owner, the Contractor shall provide such documents and information in paper copies and/or computer format (including the format of the Contractor's accounting software and/or ASCII format). The Contractor's provision of the requested documents and information shall be a condition precedent to any further proceeding under the Contract Documents or to payment of an Application for Payment.

Failure to provide the requested documents shall be a material breach of the Contract, and Contractor shall indemnify Owner for all of Owner's costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to Contractor's failure to comply with this provision. If the Contractor fails to provide the requested documents, the Contractor shall be precluded from presenting such documents in any subsequent dispute resolution proceedings, if the data was reasonably available at the time of the request.

ARTICLE 11 - COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 Cost of the Work

A. *Costs Included:* The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items, and shall not include any of the costs itemized in Paragraph 11.01.B.

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time at the Site. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health

and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.

4. Costs of special consultants (including but not limited to Engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.

5. Supplemental costs including the following:

a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

c. Construction Equipment and Machinery

(1) Rentals of all construction equipment and machinery, and the parts thereof in accordance with rental agreements approved

by Owner with the advice of Engineer, and the cost of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

(2) Costs for equipment and machinery owned by Contractor will be paid at a rate shown for such equipment in the latest edition of the Associated Equipment Distributors' rental rate manual. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs. Costs will include the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, shall cease to accrue when the use thereof is no longer necessary for the changed Work. Equipment or machinery with a value of less than \$1,000 will be considered small tools.

~~Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.~~

d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, imposed by Laws and Regulations.

e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph

5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.

g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, expresses, and similar petty cash items in connection with the Work.

i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

B. Costs Excluded: The term Cost of the Work shall not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.

2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A and 11.01.B.

C. *Contractor's Fee:* When all the Work is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 12.01.C.

D. *Documentation:* Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

11.02 Allowances

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. Cash Allowances

1. Contractor agrees that:

a. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

b. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

C. Contingency Allowance

1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.03 Unit Price Work

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement. Contractor shall not be paid for any Unit Price Work that represents an actual quantity greater than 110% of the estimated quantity, without a Change Order. The Contractor shall maintain such records as required to track the quantities of Unit Price Work in anticipation of exceeding the 110% threshold.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:

1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

2. there is no corresponding adjustment with respect any other item of Work; and

3. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 12 - CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

12.01 Change of Contract Price

A. The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted

by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or

2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).

C. *Contractor's Fee:* The Contractor's fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;

b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;

c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraph 12.01.C.2.a is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor except, the maximum total allowable costs to Owner shall be the cost of the Work plus a maximum collective

aggregate fee for Contractor and all tiers Subcontractors of 25 percent;

d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;

e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.02 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.03 *Delays*

A. Where Contractor is prevented from completing any part of the Work within the Contract Time due to delay beyond the control of Contractor, the Contract Time will be extended in an amount equal to the time lost due to such delay, if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, ~~abnormal~~ weather conditions as provided in Paragraph 12.03.A.2, or acts of God.

A.2 Weather Delays. When the Contractor is prevented from completing any part of the Work on the critical path within the Contract Time due to weather conditions, if a Claim is made therefor as provided in Paragraph 12.02.A, the Contract Times will be extended by one (1) day for each work day lost due to weather that delays Work on the critical path in excess of those in the following table:

<u>Month</u>	<u>Number of Workdays Lost Due To Weather</u>
<u>January</u>	<u>8</u>
<u>February</u>	<u>8</u>
<u>March</u>	<u>7</u>
<u>April</u>	<u>6</u>
<u>May</u>	<u>5</u>
<u>June</u>	<u>4</u>
<u>July</u>	<u>4</u>
<u>August</u>	<u>4</u>
<u>September</u>	<u>5</u>
<u>October</u>	<u>6</u>
<u>November</u>	<u>6</u>
<u>December</u>	<u>6</u>

A work day will be lost due to weather only when weather conditions reduce production by more than 50 percent on Work on the critical path. Production shall be measured by hours worked. The Contractor shall have the burden of establishing that weather conditions reduced production by more than 50 per cent on Work on the critical path.

B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

C. If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.C; it being understood and agreed that the Contractor has included in the Contract Price a contingency for the risk of such delays.

D. Owner, Engineer and the Related Entities of each of them shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of Engineers, architects, attorneys, and other professionals and all court or

arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

ARTICLE 13 - TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 *Notice of Defects*

A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. All defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspecting, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's Site safety procedures and programs so that they may comply therewith as applicable.

13.03 *Tests and Inspections*

A. All Work is subject to testing to indicate compliance with Contract Document requirements. Duplicate copies of test results of all tests required shall be submitted to Engineer. Testing laboratories used by Contractor are subject to the approval of Engineer. Tests and inspection of work may be conducted by Owner or an independent laboratory employed by Owner. Tests may also be performed in the field by Engineer as a basis for acceptance of the Work. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests. Samples required for testing shall be furnished by Contractor at no cost to Owner. In the event that completed Work does not conform to specification requirements during the initial test, the Work shall be corrected and retested for conformance. The entire cost of retesting completed Work shall be borne by Contractor. This shall include the extra cost for inspection to Owner which will be deducted from the final amount due Contractor.

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B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents **except**:

1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below, which, in fact, comprise the majority of the testing requirement for the Work.

2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in said Paragraph 13.04.C; and

3. as otherwise specifically provided in the Contract Documents.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer. Tests required by the Contract Documents to be performed by Contractor that require test certificates to be submitted to Owner or Engineer for acceptance shall be made by an independent testing laboratory or agency licensed or certified in accordance with Laws and Regulations and applicable state and local statutes. In the event state license or certification is not required, testing laboratories or agencies shall meet the following applicable requirements:

1. "Recommended Requirements for Independent Laboratory Qualification," published by the American Council of Independent Laboratories.

2. Basic requirements of ASTM E329, "Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction" as applicable.

3. Calibrate testing equipment at reasonable intervals by devices of accuracy traceable to

either the National Institute of Standards and Technology or accepted values of natural physical constants.

E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, it must, if requested by Engineer, be uncovered for observation.

F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice.

13.04 *Uncovering Work*

A. If any Work is covered contrary to the written request of Engineer, it must, if requested by Engineer, be uncovered for Engineer's observation and replaced at Contractor's expense.

B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.

C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.

D. If, the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 *Owner May Stop the Work*

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 *Correction or Removal of Defective Work*

A. Promptly after receipt of notice and so as not to delay the Project, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

13.07 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. repair such defective land or areas; or
2. correct such defective Work; or

3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and

4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications .

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for, or limitation upon, or a waiver of the provisions of any applicable statute of limitation or repose.

13.08 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to

this sentence. If any such acceptance occurs prior to Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.09 *Owner May Correct Defective Work*

~~A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct or remedy any such deficiency. If Contractor fails within two (2) business days of a written notice from the Owner or Engineer, or such longer time as may be stated in such notice, to correct, or take reasonable steps to commence to correct, defective Work or to remove and replace, or take reasonable steps to remove and replace, rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may correct or remedy any such deficiency. In such case an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor all the costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. The Contractor irrevocably designates the Owner as the Contractor's attorney-in-fact to execute the Change Orders provided for in this Paragraph 13.09.~~

B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or

for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

~~C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.~~

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

~~A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.~~

A. The Schedule of Values established as provided in Paragraph 2.07A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. The Engineer-approved version of the Application for Payment form, which includes information on completed Schedule of Values items, is to be used by the Contractor when making an Application for Progress Payment. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 Progress Payments

A. Applications for Payments

1. ~~At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. At least by the 20th day of the month (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment (including a Schedule of Values described in Paragraph 2.07.A of the Modified General Conditions) filled out and signed by Contractor covering the Work completed as of the date of the Application, and any other supporting documentation required by the Contract Documents or by the Engineer. The Application for Payment will be in the form and submitted with the number of copies of it and all related documents as required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.~~

2. Beginning with the second Application for Payment, each Application shall include ~~an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment/Contractor's Affidavit with List of Subcontractors and Suppliers with Amounts Withheld; including a certification that Contractor has paid all of its subcontractors and suppliers who were due to be paid with the proceeds of the prior Application for Payment, all using the form provided by Owner and included in the Project Manual.~~

3. ~~The amount of retainage with respect to progress payments will be as stipulated in the Agreement. Retainage. Partial payments to Contractor for labor performed shall be made at the rate of 92 percent of the amount invoiced through the Application for Payment that shows the total Contract Completion at 50 percent or greater, pursuant to Ohio Revised Code Section 153.14. After the Contract is 50 percent complete as evidenced by~~

payments in the amount of at least 50 percent of the Contract Price to Contractor, no additional funds shall be retained from payments for labor.

4. Contractor shall submit one original and five copies (unless a different quantity is otherwise agreed upon) on 8-1/2 by 11 paper of each lien waiver submitted.

5. Contractor shall submit six copies (unless a different quantity is otherwise agreed upon) of each pay request for approval.

6. No advanced payment for shop drawing preparation will be made. Shop drawing costs will be paid when equipment and materials are delivered and suitably stored on the site.

7. All stored equipment and materials for which payment is requested shall have six copies (unless a different quantity is otherwise agreed upon) of invoices included with the pay request. Equipment shall be identified thoroughly on the invoices, including serial numbers.

8. Payment for the stored equipment and material which are on the site shall not exceed the invoiced amount for each item, less the Contract retainage. The overhead and profit for the stored items shall not be invoiced until the item is installed.

9. Payment for off-site storage is normally reserved for sensitive or very large pieces of equipment that in Engineer's opinion would not be practical to have stored on the site. Payment for off-site stored items shall be limited to 75% of the invoiced value of the item, less Contract retainage. Contractor shall reimburse Owner the Cost of inspecting off-site stored items. When off-site storage is approved, Contractor shall provide Insurance Certificates and Document of Ownership to Owner.

B. Review of Applications

1. Engineer will, within 10 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Owner or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations on the Site of the executed Work as an experienced and qualified design professional and on Engineer's review of the Application for Payment and the

accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

a. the Work has progressed to the point indicated;

b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, to a final determination of quantities and classifications for Unit Price Work under Paragraph 9.07, and to any other qualifications stated in the recommendation); and

c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or

b. that there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

a. to supervise, direct, or control the Work, or

b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or

c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or

d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or

e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:

a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;

b. the Contract Price has been reduced by Change Orders;

c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; ~~or~~

d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A; or

e. the Contractor is in default of any other Agreement it has with the Owner.

C. Payment Becomes Due

1. ~~Ten~~ Thirty days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

D. Reduction in Payment

1. Owner may refuse to make payment of the full amount recommended by Engineer because:

a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;

b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;

c. there are other items entitling Owner to a set-off against the amount recommended; or

d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.

2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor corrects to Owner's satisfaction the reasons for such action.

3. If it is subsequently determined that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1.

4. Items entitling Owner to retain set-offs from the amount recommended include, but are not limited, to the following:

a. Owner compensation to Engineer at an estimated average rate of \$200 per each extra personnel hour for labor plus expenses, if applicable, because of the following Contractor-caused events:

(1) Return visits to manufacturing facilities to witness factory testing or retesting;

(2) Submittal review in excess of two reviews by Engineer for substantially the same Submittal, in accordance with Paragraph 6.17.E of these Modified General Conditions.

(3) Evaluation of proposed substitutes and in making changes to Contract Documents occasioned thereby, in accordance with Paragraph 6.05 of these Modified General Conditions.

(4) Overtime worked by Contractor necessitating Engineer, Related Entities, Resident Project Representative or Resident Project Representative's site staff, if any, to work overtime in accordance with Paragraph 6.02C of these Modified General Conditions.

b. Liability for liquidated damages incurred by Owner as set forth in the Contract Documents.

14.03 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.

14.04 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.

B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will within 14 days after submission of the tentative certificate to Owner notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Engineer considers the Work substantially complete, Engineer will within said 14 days execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and

guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer's issuing the definitive certificate of Substantial Completion, Engineer's aforesaid recommendation will be binding on Owner and Contractor until final payment.

E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to complete or correct items on the tentative list.

F. Time for Completion of Items on Tentative List and Remedies. The time fixed by the Engineer for the completion of all items on the list accompanying the tentative certificate of Substantial Completion shall not be greater than forty-five (45) days. The Contractor shall complete all items on the list within such 45-day period. If the Contractor fails to do so, the Owner in its discretion may perform the Work by itself or others and the cost thereof shall be charged to the Contractor. The Contractor irrevocably designates the Owner as the Contractor's attorney-in-fact to execute a Change Order deducting such cost from the balance of the Contract Price and also any additional costs or expenses incurred by the Owner arising out of or related to the failure of the Contractor to complete such items, including but not limited to attorneys', consultants', and Engineer's fees. The Contractor's warranties under the Contract Documents shall remain in full force and effect and cover any remedial Work, even if performed by others. If more than one inspection by the Engineer for purposes of evaluating corrected Work is required, it will be performed at the Contractor's expense.

14.05 Partial Utilization

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions.

1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor will certify to Owner and Engineer that such part of the Work is substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. Owner may at any time request Contractor in writing to permit Owner to take over operation of any part of the Work although it is not substantially complete. A copy of such request will be sent to Engineer, and within a reasonable time thereafter, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion and will prepare a list of the items remaining to be completed or corrected thereon before final payment. If Contractor does not object in writing to Owner and Engineer that such part of the Work is not ready for separate operation by Owner, Engineer will finalize the list of items to be completed or corrected and will deliver such lists to Owner and Contractor together with a written recommendation as to the division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, maintenance, utilities, insurance, warranties, and guarantees for that part of the Work which will become binding upon Owner and Contractor at the time when Owner takes over such operation (unless they shall have otherwise agreed in writing and so informed Engineer). During such operation and prior to Substantial Completion of such part of the Work, Owner shall allow Contractor reasonable access to complete or correct items on said list and to complete other related Work.

~~4.~~ 5. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 Final Inspection

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals

that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 Final Payment

A. Application for Payment

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:

a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.7;

b. consent of the surety, if any, to final payment;

c. a list of all Claims against Owner that Contractor believes are unsettled; and

d. a Contractor's Waiver and Release Agreement for itself as of the date of the Final Application for Payment and Subcontractors – Suppliers Waiver and Release Agreements for each of its Subcontractors and Suppliers as of the date of the Final Application for Payment. ~~complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.~~

~~3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner or Owner's property might in any way be responsible have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.~~

B. Engineer's Review of Application and Acceptance

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. Payment Becomes Due

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and, will be paid by Owner to Contractor.

14.08 Final Completion Delayed

A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.09 *Waiver of Claims*

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION

15.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will justify termination for cause:

1. Contractor's ~~persistent~~ failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);

2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;

3. Contractor's disregard of the authority of Engineer; or

4. Contractor's violation in any substantial way of any provisions of the Contract Documents.

B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) ~~seven~~ three business days written notice of its intent to terminate the services of Contractor:

1. exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion),

2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and

3. complete the Work as Owner may deem expedient.

Such termination shall be effective as of the date stated in the termination notice provided to Contractor.

C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph Owner shall not be required to obtain the lowest price for the Work performed.

D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within three ~~seven~~ days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.

E. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.

~~F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B, and 15.02.C.~~

15.03 *Owner May Terminate For Convenience*

A. Upon ~~seven~~ three business days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. Such termination shall be effective as of the date stated in the written notice. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work compensation as set forth in the schedule of values or Bid Form in the case of unit prices;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

~~3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and~~

3. reasonable expenses directly attributable to termination.

B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

C. Contractor shall require similar provisions contained in Paragraph 15.03 in each of its subcontracts to protect Contractor from claims by Subcontractors arising from the Owner's termination for convenience, or to minimize claims by such subcontractors. The remedy provided to Contractor under this Paragraph 15.03 shall be the Contractor's sole remedy in the event of termination for convenience by Owner.

15.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days

by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

ARTICLE 16 - DISPUTE RESOLUTION

16.01 *Methods and Procedures*

~~A. Either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.~~

A. *Settlement, Methods and Procedures*

1. In addition to Owner's entitlement to attorneys fee set forth elsewhere in the Contract Documents, in the event that Contractor files a Claim or files an action against Owner, Owner shall be entitled to make an offer of settlement of the Claim to Contractor at any time up to the date of trial. Such offer of settlement shall not be admissible into evidence at the litigation except on the issue of entitlement to recovery of attorneys' fees, costs and expenses. If at any stage of the litigation, including any appeals, Contractor's claim is dismissed or found to be without merit, or if the damages awarded to Contractor on its claim do not exceed Owner's

offer of settlement, Contractor shall be liable to Owner and shall reimburse Owner for all attorneys fees, costs and expenses incurred by Owner from the date of the offer of settlement until the date of the final adjudication and resolution of Contractor's claim.

2. Any dispute, claim or other matter not settled by negotiation or other means as mutually agreed upon by Owner, Contractor, and surety where applicable, shall be determined by the Court of Common Pleas for Stark County, Ohio, which shall have exclusive venue and jurisdiction over such matters and claims, to the exclusion of any other court, including any U.S. District Court.

~~B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.~~

~~C. If the Claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:~~

~~1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions, or~~

~~2. agrees with the other party to submit the Claim to another dispute resolution process, or~~

~~3. gives written notice to the other party of their intent to submit the Claim to a court of competent jurisdiction.~~

ARTICLE 17 – MISCELLANEOUS

17.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:

1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or

2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 *Computation of Times*

A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

17.04 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

17.05 *Controlling Law*

~~A. This Contract is to be governed by the law of the state in which the Project is located. This Contract shall be governed by the law of the State of Ohio.~~

17.06 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

17.07 *Equal Employment Opportunity and Non-Discrimination.*

A. The Contractor shall comply with, and shall require all Subcontractors of any tier to comply with, the applicable equal employment opportunity and non-discrimination statutes and regulations of the State of Ohio.

17.08 *Contract Work Hours and Safety Standard Act.*

A. All Contractors and Subcontractors, of any

tier, shall comply with the applicable federal regulations for contract work hours and safety standards.

17.09 Clean Air Act.

A. All Contractors and Subcontractors, of any tier, shall comply with the applicable standards, orders, or regulations issued pursuant to the Clean Air Act of 1970 (42 U.S.C. 1857, et seq.) and the Federal Water Pollution Control Act (33 U.S.C. 1251, et seq.), as amended.

17.10 Federal Prevailing Wage

As used in these provisions “subrecipient” means Owner, City of Massillon.

(a) Prevailing wage, generally.

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually

worked therein: Provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(ii)(A) The subrecipient(s), on behalf of EPA, shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The EPA award official shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the subrecipient(s) agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the subrecipient(s) to the State award official. The State award official will transmit the report, to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the State award official or will notify the State award official within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the and the subrecipient(s) do not

agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the award official shall refer the questions, including the views of all interested parties and the recommendation of the State award official, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii)(B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding. The subrecipient(s), shall upon written request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to

pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly, for each week in which any contract work is performed, a copy of all payrolls to the subrecipient, that is, the entity that receives the subgrant or loan from the State capitalization grant recipient. Such documentation shall be available on request of the State recipient or EPA. As to each payroll copy received, the subrecipient shall provide written confirmation in a form satisfactory to the State indicating whether or not the project is in compliance with the

requirements of 29 CFR 5.5(a)(1) based on the most recent payroll copies for the specified week. The payrolls shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on the weekly payrolls. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at <http://www.dol.gov/esa/whd/forms/wh347instr.htm> or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the subrecipient(s) for transmission to the State or EPA if requested by EPA, the State, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the subrecipient(s).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under § 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under § 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the State, EPA or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency or State may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees --

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment

as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the

approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA determines may be appropriate, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination: debarment. A breach of the

contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and subrecipient(s), State, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

(b) Contract Work Hours and Safety Standards Act. As used in these paragraphs, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-

half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (a)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The subrecipient, upon written request of the EPA Award Official or an authorized representative of the Department of Labor, shall withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

SECTION 00800

SUPPLEMENTAL MODIFIED STANDARD GENERAL CONDITIONS

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SUPPLEMENTAL MODIFIED STANDARD GENERAL CONDITIONS

Supplementary Conditions

These Supplemental Conditions amend or supplement the MODIFIED Standard General Conditions of the Construction Contract (EJCDC C-700, 2002 Edition) and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented remain in full force and effect.

SC-1.01.A.17 Drawings

Add the following sentence at the end of paragraph 1.01.A.17 of the MODIFIED Standard General Conditions.

"Drawings may also be described as Plans."

SC-1.01.A.53 Final Completion

Add the following paragraph to Article 1 of the MODIFIED Standard General Conditions.

"1.01.A.53 The project will be complete when all work is complete including all punch list items and all documents required for occupancy of the facility are completed and submitted to the OWNER. These include, but are not limited to, Certificate of Occupancy, Letters of Approval from various regulatory agencies, inspection certificates, and all other items as required in paragraph 14.07."

SC-2.05.A.3 Before Starting Construction

Add the following paragraph after paragraph 2.05.A.3 of the MODIFIED Standard General Conditions.

"The preliminary schedule of values and preliminary progress schedule will be presented in the Preconstruction Conference."

SC-4.05.A Reference Points

Delete the paragraph and replace with the following:

"A. CONTRACTOR shall provide surveys to establish reference points for construction, based on information shown on the Drawings. CONTRACTOR shall

be responsible for laying out the Work, shall protect and preserve referenced points and property monuments, and shall make no changes or relocations without the prior written approval of OWNER. CONTRACTOR shall report to ENGINEER whenever any referenced point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professional qualified personnel."

SC-6.01 Supervision and Superintendence

Add the following sentence after the first sentence of paragraph 6.01.A of the MODIFIED Standard General Conditions.

"The OWNER, the ENGINEER, and the ENGINEER's Consultant expressly disclaim any responsibilities for the means, methods, techniques, safety, sequence, and procedures of construction."

SC-6.05.E Engineer's Cost Reimbursement:

Add the following sentence at the end of paragraph 6.05.E of the MODIFIED General Conditions:

"If the CONTRACTOR proposes a substitute item, all costs associated with the use of substitute including, but not limited to, review by the ENGINEER, redesign, claims of other Contractors, additional equipment or materials required for installation, all meetings, and telephone calls, shall be at the CONTRACTOR's expense unless otherwise agreed to by the OWNER."

SC-6.11.D Use of Site and Other Areas

Add the following to paragraph 6.11.D of the MODIFIED Standard General Conditions.

"If CONTRACTOR loads or permits any part of any structure to be loaded in any manner that endangers the structure or subjects any part of the work to adjacent property to stresses or pressures that endanger it, the CONTRACTOR shall be liable for all damage arising from such loading."

SC-9.10 Progress Meetings

Add the following paragraphs to Article 9 of the MODIFIED Standard General Conditions.

9.10 Progress Meetings

- "A. The ENGINEER will schedule and hold regular progress meetings at least monthly and at other times as required. CONTRACTOR, ENGINEER, and all Subcontractors active on the site shall be represented at each meeting. CONTRACTOR may, at his discretion, request attendance by representatives of his suppliers, manufacturers, and other subcontractors.
- B. The ENGINEER will preside at the meetings and provide for keeping and distribution of the minutes. The purpose of the meetings will be to review the progress of the work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop."

SC-12.01 Change of Contract Price

Add the following paragraph immediately following paragraph 12.01.A of the MODIFIED Standard General Conditions.

"The change in contract price shall be deemed to cover all costs, overhead, and profit attributable to the change, including any delays or impacts related thereto. There will be no reservation of rights for future or further increases in contract price in connection with a particular change."

SC-17.03 Cumulative Remedies

Add the following paragraph immediately after paragraph 17.03 of the MODIFIED Standard General Conditions.

- "B. All representations, warranties, and guarantees made in the Contract Documents will survive final payment and termination or completion of the agreement."

SC-17.12 Watertight Structures

Add the following paragraphs to Article 17 of the General Conditions.

17.12 Watertight Structures

- A. "All structures to be used for holding water shall be made watertight and shall be tested by filling with water before they will be accepted. Tests of concrete water bearing basins shall be made before backfill is placed, however, where special reasons make this impracticable, the OWNER/ENGINEER/ARCHITECT may permit backfilling to proceed before

test is made. Permission to make backfill shall not relieve the CONTRACTOR from any responsibility for water tightness of the structure, and if upon making the tests the need to remove backfill arises, it shall be done by and at the expense of the CONTRACTOR.”

- B. “Structures required to withstand water pressure from outside shall also be tested as above where practicable.”
- C. “The OWNER shall supply all water for testing structures. The CONTRACTOR shall provide all additional materials, piping, valving, fuel, electricity, and all other items necessary to transport the water to the structures.”

SECTION 00850

CONTINUOUS TREATMENT

- A. Federal regulations prohibit by-passing of any sewage during construction operations. The Contractor will be responsible for providing any required temporary pumping facilities piping, etc., necessary to complete the project without any plant by-passing and continuous treatment must be provided at the same level during construction as existed prior to construction.
- B. Unless otherwise previously or subsequently specified, the Contractor shall procure and pay for all permits, licenses, and approvals necessary for the execution of his Contract.
- C. The Contractor shall comply with all laws, ordinances, rules, orders, and regulations relating to the performance of the work required to complete his Contract.
- D. The Work of the Project is defined by the Contract Documents and generally includes, but is not limited to, constructing the Work in the manner as described below. The following minimum requirements related to the construction activities and sequencing plan shall include, and be incorporated into the contractor's schedule:
 - 1. Maintenance of Sewage Flow – Sanitary sewer flow into the Massillon Wastewater Treatment Plant (WWTP) must be maintained at all times. Continuous Treatment requirements are detailed in paragraph 6.7.4, of the Owner/Contractor Agreement pages 5 and 6.
 - 2. Influent Pumping – One of the two influent screw pumps must remain fully operational at all times.
 - 3. Influent Screening - One of the two influent mechanical bar screens must remain fully operational at all times.
 - 4. Grit Removal - One of the two grit removal tanks must remain fully operational at all times.
 - 5. Flow Retention – The installation of the flow retention basin influent flow meter will require removal of a portion of the existing 42" diameter influent pipe to the flow retention basin. Downstream of the grit removal process, the Massillon WWTP can treat flows up to 21.5 MGD. Flows greater than this amount must be temporarily stored in the existing flow retention basin until flows recede below 21.5 MGD. The Contractor must provide pumps, equipment, piping, etc to allow plant flows greater than 21.5 MGD to be diverted to the flow retention basin while construction is being performed on the 42" diameter influent pipe to the flow retention basin.
 - 6. Pre-Aeration – The pre-aeration tank system is being demolished and converted into a fine screen process as shown on the drawings. All flow from the grit removal system flows to the pre-aeration tanks and then to the primary clarifiers. The Contractor may take the entire pre-aeration system (except for the common pre-aeration tank effluent channel) off-line. If the entire pre-aeration system is taken off-line, the Contractor must provide pumps, equipment, piping, etc to allow plant flows up to 21.5 MGD to

be diverted to the primary clarifier flow distribution chamber located at the southeast corner of the pre-aeration tanks. Alternately, the contractor may perform improvements in pre-aeration tank number 3 while keeping the remaining two pre-aeration tanks online. The permanent bypass channel may be installed in tank number 3 and modified so that when construction is required for tanks 1 and 2, all flow can be bypassed by gravity through the bypass channel and directed to the primary clarifier flow distribution chamber. Prior to the IFAS system becoming operational, the complete fine screen process must be operational and fully functional.

7. Primary Clarification & Sludge Pumping – During normal operations, one half of the plant flow goes to primary clarifiers 1-6 while the other half goes to primary clarifiers 7 and 8. Raw sludge from primary clarifiers 1-6 is processed through primary sludge building number 1. Raw sludge from primary clarifiers 7 and 8 is processed through primary sludge building number 2. All scum from all primary clarifiers is processed through primary sludge building number 2. Either primary clarifiers 1-6 or 7 and 8 may be taken off-line while processing all plant flows. At no time can all primary clarifiers be taken off-line.
8. Primary Effluent Pump Station (PEPS) – All flow from the primary clarifiers flow by gravity to the base of the first stage screw pumps. The PEPS must be operational and fully functional prior to demolition of the first and second stage screw pumps. The contractor may install temporary discharge piping from the PEPS to the influent piping of the existing roughing filters as shown on the drawings until the first and second stage screw pumps and primary gallery has been demolished and the new Anaerobic/Anoxic tankage along with the permanent PEPS discharge piping has been constructed. The PEPS structure shall be constructed and leak tested prior to installing equipment, piping, or utilities. This structure is anticipated to settle approximately 1 to 3 inches during construction and leak testing.
9. Civil / Site – The existing 18” gravity thickener overflow piping along the southeast corner of the existing aeration tanks needs to be relocated as shown on the drawings along with new manholes for tank drainage and scum piping installed prior to construction of the secondary clarifier distribution box number 2. Process piping and stormwater piping exiting the existing tunnel on the east side of the primary gallery needs to be extended and reconnected prior to demolition of the primary gallery and first and second stage screw pumps.
10. Primary Activation – Primary Sludge Building Number 1 can be off-line no more than 6 (consecutive) hours in order for sludge recycle piping tie-in. Primary Activation must be fully operational before the three IFAS Bioreactors are placed into service for performance testing. The Primary Clarifier Influent Bypass modification must be fully operational before the three IFAS Bioreactors are placed into service for performance testing.
11. Biological Treatment – Demolition – The First and Second-Stage Screw Pumps cannot be taken offline for demolition until the Primary Effluent Pump Station is operational and the temporary force main piping to the Roughing Filters shown on the drawings is constructed and operational.

12. Biological Treatment – Bioreactors – for current flows and loadings, a minimum of three Aeration Tanks, two Aeration Tanks and temporarily-aerated (new) Anaerobic / Anoxic tankage (as depicted on the drawings), or two retrofitted IFAS Bioreactors shall in service at all times. An “Aeration Tank” includes the tandem Roughing Filters atop the unit. Refer to the discussion of PEPS regarding temporary piping to feed the Roughing Filters. The Anaerobic / Anoxic Tanks’ propeller mixers must be available when temporary aeration of the tankage is operational in case supplemental mixing is needed. The corresponding intermediate and end Internal Recycle Pump Stations (Wells) for a particular IFAS Bioreactor must be fully operational in order to place the IFAS Bioreactor into service. Automatic controls (and related safeguards) must be fully operational with respect to PEPS and an IFAS Bioreactor before the IFAS Bioreactor is placed into service. Within 30 days of the Notice To Proceed, the Contractor shall field verify dimensions of existing tankage where Contract 1a equipment is supported and provide information to Contract 1a supplier for coordination of fabrication and installation of Contract 1a equipment that is anchored to existing tankage. The Biological Reactor Tanks (Bioreactors) shall be constructed and leak tested prior to installing equipment, piping, or utilities. This structure is anticipated to settle approximately 1 to 3 inches during construction and leak testing.
13. Temporary Aeration – The contractor shall provide a temporary medium bubble diffuser system capable of a minimum actual OTR of 11,500 lbs O₂/day and a minimum OTE of 15%.
14. Biological Treatment – Blowers (#4-6, as-modified #1-3) – Blower system modifications must be completed before any IFAS retrofit is completed and ready for testing. System modifications include aeration blower system controls. The contractor must furnish temporary aeration or means to utilize existing blowers (1 of 3, minimum) for Equalization if modifications take place during wet weather or anticipated equalization tank use. Controls may be offline for up to 8 (consecutive) hours, with blowers operated in hand.
15. Biological Treatment – RAS / WAS – Existing WAS “bleed line” or the new WAS pumps must be operational. The Tunnel Vestibule must be operational before the WAS Pumping System is activated.
16. Biological Treatment – Scum Pumping – The respective scum pump station(s) must be fully operational before any IFAS Bioreactor is placed into service. Provisional froth spray system(s) must also be fully operational before any IFAS Bioreactor is placed into service.
17. Secondary Clarification – For current flows and loadings, a minimum of four of five units must be available at all times. For short periods of time, a minimum of three units must be operational. Available and operational includes the use of an associated RAS pumping unit.
18. Tertiary Filtration – Two out of the three existing tertiary filters may be taken off-line.
19. UV Disinfection – The UV disinfection system must remain operational and fully functional from May 1st through October 31st.

20. Waste Gas Burner – The new relocated waste gas burner needs to be installed along with the associated yard piping prior to the removal and demolition of the existing waste gas burner.
21. Plant Water Systems – Either the plant utility or potable water systems must be fully operational at all times. The existing or proposed plant utility water system may be offline for a maximum of 2 (consecutive) hours, during which the contractor must provide potable or non-potable water for utility water purposes (at adequate flow and pressure). The contractor shall specifically indicate in the proposed work schedule the construction sequencing details as these relate to the construction modifications for the plant water systems.
22. Coagulant Feed – The existing ferric chloride storage & feed system may be offline for a maximum of 6 (consecutive) hours.
23. Pre-Thickening – One of the two sludge blending tanks may be taken off-line. Conversion of the sludge blending tanks to pre-thickeners must be completed prior to construction beginning on the Fine Screen process.
24. Administration Building – HVAC – The contractor must provide temporary HVAC for the Administration Building if or when required for the proposed upgrades.
25. Electrical – The contractor shall build new and temporary power distribution and associated electrical equipment to maintain power to operating facilities.
26. Plant Facility Testing – The contractor shall indicate the proposed testing sequencing of process area and systems based on testing requirements specified in the Contract Documents, including these supplementary conditions. The contractor is responsible for coordination with Contracts 1a and 1b (PEPS pumps, IFAS equipment system) for associated and combined performance testing.

END OF SECTION

DESIGN PROFESSIONAL'S CERTIFICATE OF SUBSTANTIAL COMPLETION

Project:
2013 WWTP Improvements Project

Contract For:
General Contract

Owner:
City of Massillon

CONTRACTOR: [insert name and address]
[REDACTED]

The Design Professional hereby certifies that the Date for Substantial Completion of the Contractor's Work as set forth in the Owner-Contractor Agreement is:

[REDACTED]
(Insert Date for Substantial Completion of the Work)

The Design Professional hereby certifies that the Date for Substantial Completion in the Contractor's Agreement with the Owner (the "Agreement"), as extended by Change Orders and Claims submitted by the Contractor that have been Finally Resolved, as defined below, is:

1. Date for Substantial Completion in the Agreement (above): **[REDACTED]**
2. Additional days added to Date for Substantial Completion by Change Order: **[REDACTED]**
3. Additional days added by Claims that have been Finally Resolved: **[REDACTED]**
4. Date for Substantial Completion in the Contract Adjusted by days under No. 2 and No. 3 **[REDACTED]**

"Finally Resolved" means that the Design Professional has made a decision (or declined to make a decision) on the Claim under the General Conditions and that any litigation regarding the Claim has been concluded.

The Design Professional certifies that the Contractor's Work to the best of the Design Professional's knowledge, information, and belief was Substantially Complete, as Substantial Completion is defined in the Contract Documents, on **[REDACTED]**.

The Design Professional hereby certifies that the difference between (a) the Date for Substantial Completion adjusted by the days under No. 2 and No. 3 above and (b) the date the Contractor's Work was Substantially Complete is **[REDACTED]** days.

NOTICES OF DELAY. The Design Professional hereby certifies that all "NOTICES OF DELAY" submitted by the Contractor and described in the General Conditions are attached to this Certificate. This certification is solely for the purpose of identifying all "NOTICES OF DELAY" submitted by the Contractor and is not intended to imply that any of these NOTICES OF DELAY were properly submitted in accordance with Contract Documents or are valid.

STATEMENT OF CLAIM FORMS. The Design Professional hereby certifies that all Statement of Claim Forms described in the General Conditions and submitted by the Contractor are attached to this Certificate. This certification is solely for the purpose of identifying all Statement of Claim Forms submitted by the Contractor and is not intended to imply that any of these Statement of Claim Forms were properly submitted in accordance with Contract Documents or are valid.

PUNCHLIST ITEMS. A list of items to be completed by the Contractor is attached to this Certificate. The failure to include items on this list does not change the responsibility of the Contractor to complete its Work in accordance with the Contract Documents. The Contractor shall complete all items on the Punchlist in accordance with the Contract Documents.

Security, maintenance, utilities, damage to the Work and insurance are the responsibility of the Owner and the Contractor based on their operations pursuant to final completion of the Work.

Copies of this Certificate were provided to the Contractor and the Owner on [REDACTED]

Design Professional: [REDACTED]

Signature: _____

Date: [REDACTED]

Contractor Equal Employment Opportunity Certification

During the performance of this contract, the undersigned agrees as follows:

1. The undersigned will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The undersigned will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion or national origin. Such action shall include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The undersigned agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this equal opportunity (federally assisted construction) clause.
2. The undersigned will, in all solicitations or advertisements for employees placed by or on behalf of the undersigned, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex or national origin.
3. The undersigned will send to each labor union or representative of workers, with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representative of the undersigned's commitment under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
4. The undersigned will comply with all provisions of Executive Order No. 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
5. The undersigned will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, and by the rules, regulations, and relevant orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records and accounts by the administering agency of the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
6. In the event of the undersigned's non-compliance with the equal opportunity (federally assisted construction) clause of this contract or with any of the said rules, regulations, or orders, this contract may be canceled, terminated or suspended in whole or in part, and the undersigned may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, or by rules, regulations, or order of the Secretary of Labor, or as provided by law.
7. The undersigned will include this equal opportunity (federally assisted construction) clause in every subcontract or purchase order unless exempted by the rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order No. 11246 of September 24, 1965, so that such provision will be binding upon each subcontract or vendor. The undersigned will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for non compliance: Provided, however, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor, as a result of such direction by the administering agency the undersigned may request the United States to enter into such litigation to protect the interest of the United States.

(Signature)

(Date)

(Name and Title of Signer, Please type)

(Firm Name)

Certification Regarding Debarment, Suspension, and Other Responsibility Matters INSTRUCTIONS

Under Executive Order 12549 an individual or organization debarred or excluded from participation in Federal assistance or benefit programs may not receive any assistance award under a Federal program or a subagreement thereunder for \$25,000 or more.

Accordingly, each prospective recipient of an EPA grant, loan, or cooperative agreement and any contract or subagreement participant thereunder must complete the attached certification provide an explanation why they cannot. For further details, see the regulation 40 CFR 32.510, Participants' responsibilities.

Go to www.epls.gov to access the Excluded Parties List System (EPLS). The EPLS includes information regarding entities debarred, suspended, proposed for debarment, excluded or disqualified under the nonprocurement common rule, or otherwise declared ineligible from receiving Federal contracts, certain subcontracts, and certain Federal assistance and benefits. This information may include names, addresses, DUNS numbers, Social Security Numbers, Employer Identification Numbers or other Taxpayer Identification Numbers, if available and deemed appropriate and permissible to publish by the agency taking the action.

Where To Submit

The prospective EPA grant, loan, or cooperative agreement recipient must return the signed certification or explanation with its application to Ohio EPA.

A prospective prime contractor must submit a complete certification or explanation to the individual or organization awarding the contract.

Each prospective subcontractor must submit a complete certification or explanation to the prime contractor for the project.

Applicants may reproduce these materials as needed and provide them to their prospective prime contractor, who, in turn, may reproduce and provide them to prospective subcontractors.

Additional copies / assistance may be requested from:

Ohio EPA
Division of Environmental and Financial Assistance
P.O. Box 1049
Columbus, Ohio 43216-1049
(614) 644-2798
www.epa.state.oh.us/defa/

Certification Regarding Debarment, Suspension, and Other Responsibility Matters

The prospective participant certifies to the best of its knowledge and belief that it and its principals:

- (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
- (b) Have not within a three year period preceding this proposal been convicted of or had a civil judgement rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
- (c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (b) of this certification;
- (d) Have not within a three year period preceding this application / proposal had one or more public transactions (Federal, State, or local) terminated for cause or default; and
- (e) Will not utilize a subcontractor or supplier who is unable to certify (a) through (d) above.

I understand that a false statement on this certification may be grounds for rejection of this proposal or termination of the award. In addition, under 18 USC Sec. 1001, a false statement may result in a fine of up to \$10,000 or imprisonment for up to 5 years, or both.

Type Name & Title of Authorized Representative

Signature of Authorized Representative

Date

☐ I am unable to certify to the above statements. My explanation is attached.

Disadvantaged Business Enterprise (DBE) Program DBE Subcontractor Performance Form

This form is intended to capture the DBE¹ subcontractor's² description of work to be performed and the price of the work submitted to the prime contractor. An EPA Financial Assistance Agreement Recipient must require its prime contractor to have its DBE subcontractors complete this form and include all completed forms in the prime contractors bid or proposal package.

Subcontractor Name		Project Name	
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact	
Address			
Telephone No.		Email Address	
Prime Contractor Name		Issuing/Funding Entity:	

Contract Item Number	Description of Work Submitted to the Prime Contractor Involving Construction, Services , Equipment or Supplies	Price of Work Submitted to the Prime Contractor

DBE Certified By: ☐ DOT ☐ SBA ☐ Other: _____	Meets/ exceeds EPA certification standards? ☐ YES ☐ NO ☐ Unknown

¹ A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

² Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

**Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form**

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does not signify a commitment to utilize the subcontractors above. I am aware of that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 (c).

Prime Contractor Signature	Print Name
Title	Date

Subcontractor Signature	Print Name
Title	Date

The public reporting and recordkeeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

Disadvantaged Business Enterprise (DBE) Program DBE Subcontractor Utilization Form

This form is intended to capture the prime contractor's actual and/or anticipated use of identified certified DBE¹ subcontractors² and the estimated dollar amount of each subcontract. An EPA Financial Assistance Agreement Recipient must require its prime contractors to complete this form and include it in the bid or proposal package. Prime contractors should also maintain a copy of this form on file.

Prime Contractor Name		Project Name	
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact	
Address			
Telephone No.		Email Address	
Issuing/Funding Entity:			

I have identified potential DBE certified subcontractors	☐ YES	☐ NO	
If yes, please complete the table below. If no, please explain:			
Subcontractor Name/ Company Name	Company Address/ Phone/ Email	Est. Dollar Amt	Currently DBE Certified?

Continue on back if needed

¹ A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

² Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

**Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Utilization Form**

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does not signify a commitment to utilize the subcontractors above. I am aware of that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 (c).

Prime Contractor Signature	Print Name
Title	Date

The public reporting and recordkeeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

**Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form**

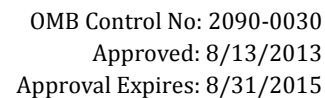
An EPA Financial Assistance Agreement Recipient must require its prime contractors to provide this form to its DBE subcontractors. This form gives a DBE¹ subcontractor² the opportunity to describe work received and/or report any concerns regarding the EPA-funded project (e.g., in areas such as termination by prime contractor, late payments, etc.). The DBE subcontractor can, as an option, complete and submit this form to the EPA DBE Coordinator at any time during the project period of performance.

Subcontractor Name		Project Name	
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact	
Address			
Telephone No.		Email Address	
Prime Contractor Name		Issuing/Funding Entity:	

Contract Item Number	Description of Work Received from the Prime Contractor Involving Construction, Services , Equipment or Supplies	Amount Received by Prime Contractor

¹ A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

² Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.



Please use the space below to report any concerns regarding the above EPA-funded project:

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Subcontractor Signature	Print Name
Title	Date

The public reporting and recordkeeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

General Decision Number: OH150002 08/21/2015 OH2

Superseded General Decision Number: OH20140002

State: Ohio

Construction Types: Heavy and Highway

Counties: Ohio Statewide.

Heavy and Highway Construction Projects

Note: Executive Order (EO) 13658 establishes an hourly minimum wage of \$10.10 for 2015 that applies to all contracts subject to the Davis-Bacon Act for which the solicitation is issued on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.10 (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract. The EO minimum wage rate will be adjusted annually. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/02/2015
1	01/23/2015
2	01/30/2015
3	02/06/2015
4	02/20/2015
5	03/20/2015
6	04/03/2015
7	04/24/2015
8	05/01/2015
9	05/08/2015
10	05/22/2015
11	05/29/2015
12	06/05/2015
13	06/12/2015
14	07/03/2015
15	07/10/2015
16	07/31/2015
17	08/07/2015
18	08/21/2015

BRKY0007-003 06/01/2011

LAWRENCE

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 28.29	16.80

BROH0001-001 07/01/2014		

DEFIANCE, FULTON (Excluding Fulton, Amboy & Swan Creek

Townships), HENRY (Excluding Monroe, Bartlow, Liberty, Washington, Richfield, Marion, Damascus & Townships & that part of Harrison Township outside corporate limits of city of Napoleon), PAULDING, PUTNAM and WILLIAMS COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 30.05	13.02

BROH0001-004 06/01/2014		

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER...	\$ 28.33	11.37

BROH0003-002 07/01/2014		

FULTON (Townships of Amboy, Swan Creek & Fulton), HENRY (Townships of Washington, Damascus, Richfield, Bartlow, Liberty, Harrison, Monroe, & Marion), LUCAS and WOOD (Townships of Perrysburg, Ross, Lake, Troy, Freedom, Montgomery, Webster, Center, Portage, Middleton, Plain, Liberty, Henry, Washington, Weston, Milton, Jackson & Grand Rapids) COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 30.05	13.02

* BROH0005-003 05/01/2015		

CUYAHOGA, LORAIN & MEDINA (Hinckley, Granger, Brunswick, Liverpool, Montville, York, Homer, Harrisville, Chatham, Litchfield & Spencer Townships and the city of Medina)

	Rates	Fringes
BRICKLAYER		
BRICKLAYERS; CAULKERS;		
CLEANERS; POINTERS; &		
STONEMASONS.....	\$ 33.81	14.00
SANDBLASTERS.....	\$ 33.81	14.00
SEWER BRICKLAYERS & STACK		
BUILDERS.....	\$ 33.81	14.00
SEWER BRICKLAYERS; STACK		
BUILDERS; & SWING SCAFFOLDS.	\$ 30.91	11.78
SWING SCAFFOLDS.....	\$ 33.81	14.00

BROH0006-005 06/01/2014		

CARROLL, COLUMBIANA (Knox, Butler, West & Hanover Townships), STARK & TUSCARAWAS

Rates	Fringes

Bricklayer, Stonemason.....	\$ 28.33	11.37

BROH0007-005 09/01/2014

PORTAGE & SUMMIT

	Rates	Fringes
BRICKLAYER.....	\$ 29.35	14.36

BROH0007-010 06/01/2014

PORTAGE & SUMMIT

	Rates	Fringes
MASON - STONE.....	\$ 28.33	11.37

BROH0008-001 06/01/2014

COLUMBIANA (Salem, Perry, Fairfield, Center, Elk Run,
Middleton, & Unity Townships and the city of New Waterford),
MAHONING & TRUMBULL

	Rates	Fringes
BRICKLAYER.....	\$ 27.10	16.89

BROH0009-002 06/01/2014

BELMONT & MONROE COUNTIES and the Townships of Warren & Mt.
Pleasant and the Village of Dillonvale in JEFFERSON COUNTY

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 28.33	11.37
Refractory.....	\$ 30.24	17.14

BROH0010-002 07/01/2013

COLUMBIANA (St. Clair, Madison, Wayne, Franklin, Washington,
Yellow Creek & Liverpool Townships) & JEFFERSON (Brush Creek &
Saline Townships)

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 26.95	15.66

BROH0014-002 06/01/2014

HARRISON & JEFFERSON (Except Mt. Pleasant, Warren, Brush Creek,
Saline & Salineville Townships & the Village of Dillonvale)

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 28.33	11.37

BROH0016-002 05/01/2014

ASHTABULA, GEAUGA, and LAKE COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 31.69	13.97

BROH0018-002 06/01/2014

BROWN, BUTLER, CLERMONT, HAMILTON, PREBLE (Gasper, Dixon, Israel, Lanier, Somers & Gratis Townships) & WARREN COUNTIES:

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 28.33	11.37

BROH0022-004 06/01/2014

CHAMPAIGN, CLARK, CLINTON, DARKE, GREENE, HIGHLAND, LOGAN, MIAMI, MONTGOMERY, PREBLE (Jackson, Monroe, Harrison, Twin, Jefferson & Washington Townships) and SHELBY COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 28.33	11.37

BROH0032-001 06/01/2014

GALLIA & MEIGS

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 28.33	11.37

BROH0035-002 06/01/2014

ALLEN, AUGLAIZE, MERCER and VAN WERT COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 28.33	11.37

BROH0039-002 06/01/2014

ADAMS & SCIOTO

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 31.27	15.89

BROH0040-003 06/01/2014

ASHLAND, CRAWFORD, HARDIN, HOLMES, MARION, MORROW, RICHLAND,
WAYNE and WYANDOT (Except Crawford, Ridge, Richland & Tymochtee
Townships) COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 28.14	16.98

FOOTNOTE: Layout Man and Sawman rate: \$1.00 per hour above
journeyman rate.

Free standing stack work ground level to top of stack;
Sandblasting and laying of carbon masonry material in swing
stage and/or scaffold; Ramming and spading of plastics and
gunniting: \$1.50 per hour above journeyman rate.

"Hot" work: \$2.50 above journeyman rate.

BROH0044-002 06/01/2014

	Rates	Fringes
Bricklayer, Stonemason COSHOCOTON, FAIRFIELD, GUERNSEY, HOCKING, KNOX, KICKING, MORGAN, MUSKINGUM, NOBLE (Beaver, Buffalo, Seneca & Wayne Townships) & PERRY COUNTIES:.....	\$ 28.33	11.37

BROH0045-002 06/01/2014

FAYETTE, JACKSON, PIKE, ROSS and VINTON COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 29.88	12.89

BROH0046-002 06/01/2014

ERIE, HANCOCK, HURON, OTTAWA, SANDUSKY, SENECA, WOOD (Perry &
Bloom Townships) and WYANDOT (Tymochtee, Crawford, Ridge &
Richland Townships) COUNTIES & the Islands of Lake Erie north
of Sandusky

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 28.14	16.98

FOOTNOTE: Layout Man and Sawman rate: \$1.00 per hour above
journeyman rate.

Free standing stack work ground level to top of stack;

Sandblasting and laying of carbon masonry material in swing stage and/or scaffold; Ramming and spading of plastics and gunniting: \$1.50 per hour above journeyman rate.
"Hot" work: \$2.50 above journeyman rate.

BROH0052-001 06/01/2014

ATHENS COUNTY

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 28.33	11.37

BROH0052-003 06/01/2014

NOBLE (Brookfield, Noble, Center, Sharon, Olive, Enoch, Stock, Jackson, Jefferson & Elk Townships) and WASHINGTON COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 27.77	14.93

BROH0055-003 06/01/2014

DELAWARE, FRANKLIN, MADISON, PICKAWAY and UNION COUNTIES

	Rates	Fringes
Bricklayer, Stonemason.....	\$ 29.88	12.89

CARP0003-004 05/01/2014

MAHONING & TRUMBULL

	Rates	Fringes
CARPENTER.....	\$ 25.61	15.10

CARP0069-003 05/01/2014

CARROLL, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
CARPENTER.....	\$ 25.50	13.67

CARP0069-006 05/01/2014

COSHOCTON, HOLMES, KNOX & MORROW

	Rates	Fringes
CARPENTER.....	\$ 23.66	13.05

CARP0171-002 05/01/2014

BELMONT, COLUMBIANA, HARRISON, JEFFERSON & MONROE

	Rates	Fringes
CARPENTER.....	\$ 26.02	15.49

 CARP0200-002 05/01/2014

ADAMS, ATHENS, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, GALLIA,
 GUERNSEY, HIGHLAND, HOCKING, JACKSON, LAWRENCE, LICKING,
 MADISON, MARION, MEIGS, MORGAN, MUSKINGUM, NOBLE, PERRY,
 PICKAWAY, PIKE, ROSS, SCIOTO, UNION, VINTON and WASHINGTON
 COUNTIES

	Rates	Fringes
CARPENTER.....	\$ 28.22	13.50
Diver.....	\$ 39.41	10.40
PILEDRIVERMAN.....	\$ 28.22	13.50

 CARP0248-005 07/01/2008

LUCAS & WOOD

	Rates	Fringes
CARPENTER.....	\$ 27.27	14.58

 CARP0248-008 07/01/2008

	Rates	Fringes
CARPENTER DEFIANCE, FULTON, HANCOCK, HENRY, PAULDING & WILLIAMS COUNTIES.....	\$ 23.71	13.28

 CARP0254-002 05/01/2014

ASHTABULA, CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
CARPENTER.....	\$ 31.61	14.46

 CARP0372-002 07/01/2008

ALLEN, AUGLAIZE, HARDIN, MERCER, PUTNAM & VAN WERT

	Rates	Fringes
CARPENTER.....	\$ 23.18	13.28

 CARP0639-003 05/01/2014

MEDINA, PORTAGE & SUMMIT

	Rates	Fringes
CARPENTER.....	\$ 29.59	14.64

CARP0735-002 05/01/2014		

ASHLAND, ERIE, HURON, LORAIN & RICHLAND

	Rates	Fringes
CARPENTER.....	\$ 24.80	13.29

CARP1311-001 05/01/2014		

BROWN, BUTLER, CHAMPAIGN, CLARK, CLERMONT, CLINTON, DARKE,
GREENE, HAMILTON, LOGAN, MIAMI, MONTGOMERY, PREBLE, SHELBY &
WARREN

	Rates	Fringes
Carpenter & Piledrivermen.....	\$ 27.39	14.33
Diver.....	\$ 40.58	9.69

CARP1393-002 07/01/2008		

CRAWFORD, DEFIANCCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA,
PAULDING, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
Piledrivermen & Diver's Tender...	\$ 27.30	16.05

DIVERS - \$250.00 per day		

CARP1393-003 07/01/2008		

ALLEN, AUGLAIZE, HARDIN, MERCER, PUTNAM, VAN WERT & WYANDOT

	Rates	Fringes
Piledrivermen & Diver's Tender...	\$ 25.15	15.92

DIVERS - \$250.00 per day		

CARP1871-006 06/01/2013		

BELMONT, HARRISON, & MONROE

	Rates	Fringes
Diver, Wet.....	\$ 47.07	13.92
Piledrivermen; Diver, Dry.....	\$ 31.38	13.92

CARP1871-008 06/01/2013

ASHLAND, ASHTABULA, CUYAHOGA, ERIE, GEAUGA, HURON, LAKE,
LORAIN, MEDINA, PORTAGE, RICHLAND & SUMMIT

	Rates	Fringes
Diver, Wet.....	\$ 44.22	15.49
Piledrivermen; Diver, Dry.....	\$ 29.48	15.49

CARP1871-014 06/01/2013

CARROLL, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
Diver, Wet.....	\$ 37.40	13.81
Piledrivermen; Diver, Dry.....	\$ 24.93	13.81

CARP1871-015 06/01/2013

COSHOCTON, HOLMES, KNOX & MORROW

	Rates	Fringes
Diver, Wet.....	\$ 36.53	12.96
Piledrivermen; Diver, Dry.....	\$ 24.35	12.96

CARP1871-017 06/01/2013

MAHONING & TRUMBULL

	Rates	Fringes
Diver, Wet.....	\$ 39.44	14.16
Piledrivermen; Diver, Dry.....	\$ 26.29	14.16

CARP2235-012 01/01/2014

COLUMBIANA & JEFFERSON

	Rates	Fringes
PILEDRIVERMAN.....	\$ 31.74	16.41

CARP2239-001 07/01/2008

CRAWFORD, OTTAWA, SANDUSKY, SENECA & WYANDOT

	Rates	Fringes
CARPENTER.....	\$ 23.71	13.28

ELEC0008-002 05/26/2014

DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING,

PUTNAM, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
CABLE SPLICER.....	\$ 38.98	18.96
ELECTRICIAN.....	\$ 37.12	18.88

ELEC0032-003 06/01/2014

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, SHELBY, VAN WERT &
WYANDOT (Crawford, Jackson, Marseilles, Mifflin, Ridgeland,
Ridge & Salem Townships)

	Rates	Fringes
ELECTRICIAN.....	\$ 28.32	15.18

ELEC0032-004 06/01/1998

ALLEN, HARDIN, VAN WERT & WYANDOT (Crawford, Jackson,
Marseilles, Mifflin, Richland, Ridge & Salem Townships)

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 20.27	4.12+a
Groundman Truck Driver.....	\$ 14.43	3.63+a
Lineman.....	\$ 22.52	4.31+a

FOOTNOTE: a. Half day's Paid Holiday: The last 4 hours of
the workday prior to Christmas or New Year's Day

ELEC0038-002 04/28/2014

CUYAHOGA, GEAUGA (Bainbridge, Chester & Russell Townships) &
LORAIN (Columbia Township)

	Rates	Fringes
ELECTRICIAN		
Excluding Sound & Communications Work.....	\$ 36.78	19.72

FOOTNOTES;

- a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th;
Labor Day; Thanksgiving Day; & Christmas Day
- b. 1 week's paid vacation for 1 year's service; 2 weeks' paid
vacation for 2 or more years' service

ELEC0038-008 04/27/2015

CUYAHOGA, GEAUGA (Bainbridge, Chester & Russell Townships) &
LORAIN (Columbia Township)

	Rates	Fringes
Sound & Communication Technician		
Communications Technician...	\$ 26.05	10.40+a+b
Installer Technician.....	\$ 24.55	10.11+a+b

FOOTNOTES;

- a. 6 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; & Christmas Day
- b. 1 week's paid vacation for 1 year's service; 2 weeks' paid vacation for 2 or more years' service

ELEC0064-003 11/25/2013

COLUMBIANA (Butler, Fairfield, Perry, Salem & Unity Townships)
MAHONING (Austintown, Beaver, Berlin, Boardman, Canfield, Ellsworth, Coitsville, Goshen, Green, Jackson, Poland, Springfield & Youngstown Townships), & TRUMBULL (Hubbard & Liberty Townships)

	Rates	Fringes
ELECTRICIAN.....	\$ 31.02	12.91

ELEC0071-001 12/29/2014

ASHLAND, CHAMPAIGN, CLARK, COSHOCTON, CRAWFORD, DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, GUERNSEY, HIGHLAND, HOCKING, JACKSON (Coal, Jackson, Liberty, Milton, Washington & Wellston Townships), KNOX, LICKING, MADISON, MARION, MONROE, MORGAN, MORROW, MUSKINGUM, NOBLE, PERRY, PICKAWAY, PIKE (Beaver, Benton, Jackson, Mifflin, Pebble, Peepee, Perry & Seal Townships), RICHLAND, ROSS, TUSCARAWAS (Auburn, Bucks, Clay, Jefferson, Oxford, Perry, Salem, Rush, Washington & York Townships), UNION, VINTON (Clinton, Eagle, Elk, Harrison, Jackson, Richland & Swan Townships), and WASHINGTON COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operators.....	\$ 31.52	12.00
Groundmen.....	\$ 22.76	10.07
Linemen & Cable Splicers....	\$ 35.02	12.76

ELEC0071-004 12/29/2014

AUGLAIZE, CLINTON, DARKE, GREENE, LOGAN, MERCER, MIAMI, MONTGOMERY, PREBLE, and SHELBY COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 31.52	12.00
Groundman.....	\$ 22.76	10.07
Lineman & Cable Splicers....	\$ 35.02	12.76

ELEC0071-005 12/30/2013		

ASHTABULA, CUYAHOGA, GEAUGA, LAKE & LORAIN

	Rates	Fringes
LINE CONSTRUCTION: Equipment Operator		
DOT/Traffic Signal & Highway Lighting Projects...	\$ 29.02	11.96
Municipal Power/Transit Projects.....	\$ 37.21	13.93
LINE CONSTRUCTION: Groundman		
DOT/Traffic Signal & Highway Lighting Projects...	\$ 22.57	10.42
Municipal Power/Transit Projects.....	\$ 28.94	11.95
LINE CONSTRUCTION: Linemen/Cable Splicer		
DOT/Traffic Signal & Highway Lighting Projects...	\$ 32.39	12.75
Municipal Power/Transit Projects.....	\$ 41.35	14.92

ELEC0071-008 12/29/2014		

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 31.52	12.00
Groundman.....	\$ 22.76	10.07
Lineman & Cable Splicers....	\$ 35.02	12.76

ELEC0071-010 12/29/2014		

BELMONT, CARROLL, HARRISON, HOLMES, JEFFERSON, MEDINA, PORTAGE, STARK, SUMMIT, and WAYNE COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 31.52	12.00
Groundman.....	\$ 22.76	10.07
Lineman & Cable Splicers....	\$ 35.02	12.76

ELEC0071-013 12/29/2014		

BROWN, BUTLER, CLERMONT, HAMILTON, and WARREN COUNTIES

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 31.52	12.00
Groundman.....	\$ 22.76	10.07
Lineman & Cable Splicers....	\$ 35.02	12.76

ELEC0071-014 12/29/2014		

ADAMS, ATHENS, GALLIA, JACKSON (Bloomfield, Franklin, Hamilton, Lick, Jefferson, Scioto & Madison Townships), LAWRENCE, MEIGS, PIKE (Camp Creek, Marion, Newton, Scioto, Sunfish & Union Townships), SCIOTO & VINTON (Brown, Knox, Madison, Vinton & Wilkesville Townships)

	Rates	Fringes
Line Construction		
Equipment Operator.....	\$ 31.52	12.00
Groundman.....	\$ 22.76	10.07
Lineman & Cable Splicers....	\$ 35.02	12.76

ELEC0082-002 12/01/2014		

CLINTON, DARKE, GREENE, MIAMI, MONTGOMERY, PREBLE & WARREN (Wayne, Clear Creek & Franklin Townships)

	Rates	Fringes
ELECTRICIAN.....	\$ 27.70	17.39

ELEC0082-006 12/01/2014		

CLINTON, DARKE, GREENE, MIAMI, MONTGOMERY, PREBLE & WARREN (Wayne, Clear Creek & Franklin Townships)

	Rates	Fringes
Sound & Communication Technician		
Cable Puller.....	\$ 10.24	4.91
Installer/Technician.....	\$ 22.75	9.91

ELEC0129-003 03/01/2010		

LORAIN (Except Columbia Township) & MEDINA (Litchfield & Liverpool Townships)

Rates	Fringes

ELECTRICIAN.....	\$ 31.00	13.80

ELEC0129-004 03/01/2010

ERIE & HURON (Lyme, Ridgefield, Norwalk, Townsend, Wakeman,
Sherman, Peru, Bronson, Hartland, Clarksfield, Norwich,
Greenfield, Fairfield, Fitchville & New London Townships)

	Rates	Fringes
ELECTRICIAN.....	\$ 31.00	13.80

ELEC0141-003 09/01/2014

BELMONT COUNTY

	Rates	Fringes
CABLE SPLICER.....	\$ 31.75	23.16
ELECTRICIAN.....	\$ 28.35	23.05

ELEC0212-003 07/01/2013

BROWN, CLERMONT & HAMILTON

	Rates	Fringes
Sound & Communication Technician.....	\$ 22.50	9.51

ELEC0212-005 06/01/2015

BROWN, CLERMONT, and HAMILTON COUNTIES

	Rates	Fringes
ELECTRICIAN.....	\$ 27.03	17.02

ELEC0245-003 08/26/2013

DEFIANCE, FULTON, HANCOCK, HENRY, HURON, LUCAS, OTTAWA,
PAULDING, PUTNAM, SANDUSKY, SENECA, WILLIAMS, and WOOD COUNTIES

	Rates	Fringes
Line Construction		
Cable Splicer.....	\$ 39.72	24.77%+\$5.00+a
Groundman/Truck Driver.....	\$ 15.11	24.77%+\$5.00+a
Heli-arc Welding.....	\$ 34.84	24.77%+\$5.00+a
Lineman.....	\$ 24.54	24.77%+\$5.00+a
Operator - Class 1.....	\$ 27.63	24.77%+\$5.00+a
Operator - Class 2.....	\$ 24.18	24.77%+\$5.00+a
Traffic Signal & Lighting Technician.....	\$ 31.09	24.77%+\$5.00+a

FOOTNOTE: a. 6 Observed Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; & Christmas Day. Employees who work on a holiday shall be paid at a rate of double their applicable classified straight-time rates for the work performed on such holiday.

ELEC0245-004 09/01/2014

ERIE COUNTY

	Rates	Fringes
Line Construction		
Cable Splicer.....	\$ 40.83	25.20%+\$5.00+a
Groundman/Truck Driver.....	\$ 15.53	25.20%+\$5.00+a
Lineman.....	\$ 35.50	25.20%+\$5.00+a
Operator - Class 1.....	\$ 28.40	25.20%+\$5.00+a
Operator - Class 2.....	\$ 24.85	25.20%+\$5.00+a

FOOTNOTE: a. 6 Observed Holidays: New Year's Day; Memorial Day; Independence Day; Labor Day; Thanksgiving Day; & Christmas Day. Employees who work on a holiday shall be paid at a rate of double their applicable classified straight-time rates for the work performed on such holiday.

ELEC0246-006 10/29/2012

	Rates	Fringes
ELECTRICIAN.....	\$ 33.00	26.16

ELEC0306-005 05/26/2014

MEDINA (Brunswick, Chatham, Granger, Guilford, Harrisville, Hinckley, Homer, Lafayette, Medina, Montville, Sharon, Spencer, Wadsworth, Westfield & York Townships), PORTAGE (Atwater, Aurora, Brimfield, Deerfield, Franklin, Mantua, Randolph, Ravenna, Rootstown, Shalersville, Streetsboro & Suffield Townships), SUMMIT & WAYNE (Baughman, Canaan, Chester, Chippewa, Congress, Green, Milton, & Wayne Townships)

	Rates	Fringes
CABLE SPLICER.....	\$ 36.22	5%+14.86
ELECTRICIAN.....	\$ 34.04	5%+14.86

ELEC0317-002 05/28/2014

GALLIA & LAWRENCE

	Rates	Fringes
CABLE SPLICER.....	\$ 32.68	18.13
ELECTRICIAN.....	\$ 32.62	21.45

ELEC0540-003 06/05/1997

TUSCARAWAS COUNTY (North of Auburn, Clay, Rush & York Townships)

	Rates	Fringes
Line Construction		
Groundman; & Truck Driver...\$ 14.65		8.18
Line Equipment Operator.....\$ 19.02		8.69
Lineman; & Cable Splicer....\$ 21.86		9.01

ELEC0540-005 01/01/2015

CARROLL (Northern half, including Fox, Harrison, Rose & Washington Townships), COLUMBIANA (Knox Township), HOLMES, MAHONING (Smith Township), STARK, TUSCARAWAS (North of Auburn, Clay, Rush & York Townships), and WAYNE (South of Baughman, Chester, Green & Wayne Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN.....\$ 29.96		20.82

ELEC0573-003 06/01/2015

ASHTABULA (Colebrook, Wayne, Williamsfield, Orwell & Windsor Townships), GEAUGA (Auburn, Middlefield, Parkman & Troy Townships), MAHONING (Milton Township), PORTAGE (Charlestown, Edinburg, Freedom, Hiram, Nelson, Palmyra, Paris & Windham Townships), and TRUMBULL (Except Liberty & Hubbard Townships)

	Rates	Fringes
ELECTRICIAN.....\$ 30.57		16.85

ELEC0575-001 06/02/2015

ADAMS, FAYETTE, HIGHLAND, HOCKING, JACKSON (Bloomfield, Franklin, Hamilton, Jefferson, Lick, Madison, Scioto, Coal, Jackson, Liberty, Milton & Washington Townships), PICKAWAY (Deer Creek, Perry, Pickaway, Salt Creek & Wayne Townships), PIKE (Beaver, Benton, Jackson, Mifflin, Pebble, PeePee, Perry, Seal, Camp Creek, Newton, Scioto, Sunfish, Union & Marion Townships), ROSS, SCIOTO & VINTON (Clinton, Eagle, Elk, Harrison, Jackson, Richland & Swan Townships)

	Rates	Fringes
ELECTRICIAN.....\$ 31.70		14.58

ELEC0648-001 09/01/2014

BUTLER and WARREN COUNTIES (Deerfield, Hamilton, Harlan,

Massie, Salem, Turtle Creek, Union & Washington Townships)

	Rates	Fringes
CABLE SPLICER.....	\$ 28.83	16.29
ELECTRICIAN.....	\$ 28.33	16.27

ELEC0673-004 06/01/2015

ASHTABULA (Excluding Orwell, Colebrook, Williamsfield, Wayne & Windsor Townships), GEAUGA (Burton, Chardon, Claridon, Hambden, Huntsburg, Montville, Munson, Newbury & Thompson Townships) and LAKE COUNTIES

	Rates	Fringes
CABLE SPLICER.....	\$ 33.29	17.11
ELECTRICIAN.....	\$ 33.37	18.05

ELEC0683-002 06/02/2014

CHAMPAIGN, CLARK, DELAWARE, FAIRFIELD, FRANKLIN, MADISON, PICKAWAY (Circleville, Darby, Harrison, Jackson, Madison, Monroe, Muhlenberg, Scioto, Walnut & Washington Townships), and UNION COUNTIES

	Rates	Fringes
CABLE SPLICER.....	\$ 31.45	15.85
ELECTRICIAN.....	\$ 30.85	15.85

ELEC0688-003 06/02/2014

ASHLAND, CRAWFORD, HURON (Richmond, New Haven, Ripley & Greenwich Townships), KNOX (Liberty, Clinton, Union, Howard, Monroe, Middleberry, Morris, Wayne, Berlin, Pike, Brown & Jefferson Townships), MARION, MORROW, RICHLAND and WYANDOT (Sycamore, Crane, Eden, Pitt, Antrim & Tymochtee Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN.....	\$ 26.75	15.31

ELEC0972-002 06/01/2014

ATHENS, MEIGS, MONROE, MORGAN, NOBLE, VINTON (Brown, Knox, Madison, Vinton & Wilkesville Townships), and WASHINGTON COUNITIES

Rates	Fringes

CABLE SPLICER.....	\$ 32.49	21.33
ELECTRICIAN.....	\$ 32.24	21.33

ELEC1105-001 06/02/2014

COSHOCTON, GUERNSEY, KNOX (Jackson, Clay, Morgan, Miller, Milford, Hilliar, Butler, Harrison, Pleasant & College Townships), LICKING, MUSKINGUM, PERRY, and TUSCARAWAS (Auburn, York, Clay, Jefferson, Rush, Oxford, Washington, Salem, Perry & Bucks Townships) COUNTIES

	Rates	Fringes
ELECTRICIAN.....	\$ 29.18	15.44

ENGI0018-003 05/01/2015

ASHTABULA, CUYAHOGA, ERIE, GEAUGA, LAKE, LORAIN, MEDINA, PORTAGE, and SUMMIT COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
GROUP 1.....	\$ 34.83	14.25
GROUP 2.....	\$ 34.73	14.25
GROUP 3.....	\$ 33.69	14.25
GROUP 4.....	\$ 32.47	14.25
GROUP 5.....	\$ 27.18	14.25
GROUP 6.....	\$ 35.08	14.25
GROUP 7.....	\$ 35.33	14.25

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Air Compressor on Steel Erection; Barrier Moving Machine; Boiler Operator on Compressor or Generator when mounted on a Rig; Cableway; Combination Concrete Mixer & Tower; Concrete Plant (over 4 yd. Capacity); Concrete Pump; Crane (All Types, Including Boom Truck, Cherry Picker); Crane-Compact, Track or Rubber over 4,000 lbs. capacity; Cranes-Self Erecting, Stationary, Track or Truck (All Configurations); Derrick; Dragline; Dredge (Dipper, Clam or Suction); Elevating Grader or Euclid Loader; Floating Equipment (All Types); Gradall; Helicopter Crew (Operator-Hoist or Winch); Hoe (all types); Hoisting Engine on Shaft or Tunnel Work; Hydraulic Gantry (Lifting System); Industrial-Type Tractor; Jet Engine Dryer (D8 or D9) Diesel Tractor; Locomotive (Standard Gauge); Maintenance Operator Class A; Mixer, Paving (Single or Double Drum); Mucking Machine; Multiple Scraper; Piledriving Machine (All Types); Power Shovel; Prentice Loader; Quad 9 (Double Pusher); Rail Tamper (with auto lifting & aligning device); Refrigerating Machine (Freezer Operation); Rotary Drill, on Caisson work; Rough Terrain Fork Lift with Winch/Hoist; Side-Boom; Slip-Form Paver; Tower Derrick; Tree Shredder; Trench Machine (Over 24" wide); Truck Mounted Concrete Pump; Tug

Boat; Tunnel Machine and/or Mining Machine; Wheel Excavator; and Asphalt Plant Engineer (Cleveland District Only).

GROUP 2 - Asphalt Paver; Automatic Subgrader Machine, Self-Propelled (CMI Type); Bobcat Type and/or Skid Steer Loader with Hoe Attachment Greater than 7,000 lbs.; Boring Machine More than 48"; Bulldozer; Endloader; Horizontal Directional Drill (Over 50,000 ft lbs thrust); Hydro Milling Machine; Kolman-type Loader (production type-Dirt); Lead Greaseman; Lighting & Traffic Signal Installation Equipment (includes all groups or classifications); Material Transfer Equipment (Shuttle Buggy) Asphalt; Pettibone-Rail Equipment; Power Grader; Power Scraper; Push Cat; Rotomill (all), Grinders & Planers of All types; Trench Machine (24" wide & under); Vermeer type Concrete Saw; and Maintenance Operators (Portage and Summit Counties Only).

GROUP 3 - A-Frame; Air Compressor on Tunnel Work (low pressure); Asphalt Plant Engineer (Portage and Summit Counties Only); Bobcat-type and/or Skid Steer Loader with or without Attachments; Highway Drills (all types); Locomotive (narrow gauge); Material Hoist/Elevator; Mixer, Concrete (more than one bag capacity); Mixer, one bag capacity (Side Loader); Power Boiler (Over 15 lbs. Pressure) Pump Operator installing & operating Well Points; Pump (4" & over discharge); Roller, Asphalt; Rotovator (lime soil stabilizer); Switch & Tie Tampers (without lifting & aligning device); Utility Operator (Small equipment); Welding Machines; and Railroad Tie Insertor/Remover; Articulating/straight bed end dumps if assigned (minus \$4.00 per hour.

GROUP 4 - Backfiller; Ballast Re-locator; Bars, Joint & Mesh Installing Machine; Batch Plant; Boring Machine Operator (48" or less); Bull Floats; Burlap & Curing Machine; Concrete Plant (capacity 4 yd. & under); Concrete Saw (Multiple); Conveyor (Highway); Crusher; Deckhand; Farm-type Tractor with attachments (highway); Finishing Machine; Fireperson, Floating Equipment (all types); Forklift; Form Trencher; Hydro Hammer expect masonry; Hydro Seeder; Pavement Breaker; Plant Mixer; Post Driver; Post Hole Digger (Power Auger); Power Brush Burner; Power Form Handling Equipment; Road Widening Trencher; Roller (Brick, Grade & Macadam); Self-Propelled Power Spreader; Self-Propelled Power Subgrader; Steam Fireperson; Tractor (Pulling Sheepfoot, Roller or Grader); and Vibratory Compactor with Integral Power.

GROUP 5 - Compressor (Portable, Sewer, Heavy & Highway); Drum Fireperson (Asphalt Plant); Generator; Masonry Fork Lift; Inboard-Outboard Motor Boat Launch; Oil Heater (asphalt plant); Oiler/Helper; Power Driven Heater; Power Sweeper & Scrubber; Pump (under 4" discharge); Signalperson; Tire Repairperson; VAC/ALLS; Cranes - Compact, track or rubber under 4,000 pound capacity; fueling and greasing; and

Chainmen.

GROUP 6 - Master Mechanic & Boom from 150 to 180.

GROUP 7 - Boom from 180 and over.

ENGI0018-004 05/01/2015

ADAMS, ALLEN, ASHLAND, ATHENS, AUGLAIZE, BELMONT, BROWN,
BUTLER, CARROLL, CHAMPAIGN, CLARK, CLERMONT, CLINTON,
COSHOCOTON, CRAWFORD, DARKE, DEFIANCE, DELAWARE, FAIRFIELD,
FAYETTE, FRANKLIN, FULTON, GALLIA, GREENE, GUERNSEY, HAMILTON,
HANCOCK, HARDIN, HARRISON, HENRY, HIGHLAND, HOCKING, HOLMES,
HURON, JACKSON, JEFFERSON, KNOX, LAWRENCE, LICKING, LOGAN,
LUCAS, MADISON, MARION, MEIGS, MERCER, MIAMI, MONROE,
MONTGOMERY, MORGAN, MORROW, MUSKINGUM, NOBLE, OTTAWA, PAULDING,
PERRY, PICKAWAY, PIKE, PREBLE, PUTNAM, RICHLAND, ROSS,
SANDUSKY, SCIOTO, SENECA, SHELBY, STARK, TUSCARAWAS, UNION, VAN
WERT, VINTON, WARREN, WASHINGTON, WAYNE, WILLIAMS, WOOD, and
YANDOT COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
GROUP 1.....	\$ 33.34	14.25
GROUP 2.....	\$ 33.22	14.25
GROUP 3.....	\$ 32.18	14.25
GROUP 4.....	\$ 31.00	14.25
GROUP 5.....	\$ 25.54	14.25
GROUP 6.....	\$ 33.59	14.25
GROUP 7.....	\$ 33.84	14.25

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Air Compressor on Steel Erection; Barrier Moving
Machine; Boiler Operator on Compressor or Generator when
mounted on a Rig; Cableway; Combination Concrete Mixer &
Tower; Concrete Plant (over 4 yd. Capacity); Concrete Pump;
Crane (All Types, Including Boom Truck, Cherry Picker);
Crane-Compact, Track or Rubber over 4,000 lbs. capacity;
Cranes-Self Erecting, Stationary, Track or Truck (All
Configurations); Derrick; Dragline; Dredge (Dipper, Clam or
Suction); Elevating Grader or Euclid Loader; Floating
Equipment (All Types); Gradall; Helicopter Crew
(Operator-Hoist or Winch); Hoe (all types); Hoisting Engine
on Shaft or Tunnel Work; Hydraulic Gantry (Lifting
System); Industrial-Type Tractor; Jet Engine Dryer (D8 or
D9) Diesel Tractor; Locomotive (Standard Gauge);
Maintenance Operator Class A; Mixer, Paving (Single or
Double Drum); Mucking Machine; Multiple Scraper;
Piledriving Machine (All Types); Power Shovel; Prentice
Loader; Quad 9 (Double Pusher); Rail Tamper (with auto
lifting & aligning device); Refrigerating Machine (Freezer
Operation); Rotary Drill, on Caisson work; Rough Terrain
Fork Lift with Winch/Hoist; Side-Boom; Slip-Form Paver;

Tower Derrick; Tree Shredder; Trench Machine (Over 24" wide); Truck Mounted Concrete Pump; Tug Boat; Tunnel Machine and/or Mining Machine; and Wheel Excavator.

GROUP 2 - Asphalt Paver; Automatic Subgrader Machine, Self-Propelled (CMI Type); Bobcat Type and/or Skid Steer Loader with Hoe Attachment Greater than 7,000 lbs.; Boring Machine More than 48"; Bulldozer; Endloader; Hydro Milling Machine; Horizontal Directional Drill (over 50,000 ft. lbs. thrust); Kolman-type Loader (production type-Dirt); Lead Greaseman; Lighting & Traffic Signal Installation Equipment (includes all groups or classifications); Material Transfer Equipment (Shuttle Buggy) Asphalt; Pettibone-Rail Equipment; Power Grader; Power Scraper; Push Cat; Rotomill (all), Grinders & Planers of All types; Trench Machine (24" wide & under); and Vermeer type Concrete Saw.

GROUP 3 - A-Frame; Air Compressor on Tunnel Work (low pressure); Asphalt Plant Engineer; Bobcat-type and/or Skid Steer Loader with or without Attachments; Highway Drills (all types); Locomotive (narrow gauge); Material Hoist/Elevator; Mixer, Concrete (more than one bag capacity); Mixer, one bag capacity (Side Loader); Power Boiler (Over 15 lbs. Pressure) Pump Operator installing & operating Well Points; Pump (4" & over discharge); Railroad Tie Inserter/Remover; Roller, Asphalt; Rotovator (lime soil stabilizer); Switch & Tie Tampers (without lifting & aligning device); Utility Operator (Small equipment); and Welding Machines; Articulating/straight bed end dumps if assigned (minus \$4.00 per hour).

GROUP 4 - Backfiller; Ballast Re-locator; Bars, Joint & Mesh Installing Machine; Batch Plant; Boring Machine Operator (48" or less); Bull Floats; Burlap & Curing Machine; Concrete Plant (capacity 4 yd. & under); Concrete Saw (Multiple); Conveyor (Highway); Crusher; Deckhand; Farm-type Tractor with attachments (highway); Finishing Machine; Fireperson, Floating Equipment (all types); Fork Lift; Form Trencher; Hydro Hammer except masonry; Hydro Seeder; Pavement Breaker; Plant Mixer; Post Driver; Post Hole Digger (Power Auger); Power Brush Burner; Power Form Handling Equipment; Road Widening Trencher; Roller (Brick, Grade & Macadam); Self-Propelled Power Spreader; Self-Propelled Power Subgrader; Steam Fireperson; Tractor (Pulling Sheepfoot, Roller or Grader); and Vibratory Compactor with Integral Power.

GROUP 5 - Compressor (Portable, Sewer, Heavy & Highway); Drum Fireperson (Asphalt Plant); Generator; Masonary Forklift; Inboard-Outboard Motor Boat Launch; Oil Heater (asphalt plant); Oiler/Helper; Power Driven Heater; Power Sweeper & Scrubber; Pump (under 4" discharge); Signalperson; Tire Repairperson; VAC/ALLS; Cranes - Compact, track or rubber under 4,000 pound capacity; fueling and greasing; and Chainmen.

GROUP 6 - Master Mechanic & Boom from 150 to 180.

GROUP 7 - Boom from 180 and over.

ENGI0066-023 06/01/2014

COLUMBIANA, MAHONING & TRUMBULL COUNTIES

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
ASBESTOS; HAZARDOUS/TOXIC		
WASTE PROJECTS		
GROUP 1 - A & B.....	\$ 37.55	17.51
ASBESTOS; HAZARDOUS/TOXIC		
WASTE PROJECTS		
GROUP 2 - A & B.....	\$ 37.22	17.51
ASBESTOS; HAZARDOUS/TOXIC		
WASTE PROJECTS		
GROUP 3 - A & B.....	\$ 33.49	17.51
ASBESTOS; HAZARDOUS/TOXIC		
WASTE PROJECTS		
GROUP 4 - A & B.....	\$ 29.54	17.51
ASBESTOS; HAZARDOUS/TOXIC		
WASTE PROJECTS		
GROUP 5 - A & B.....	\$ 26.15	17.51
HAZARDOUS/TOXIC WASTE		
PROJECTS		
GROUP 1 - C & D.....	\$ 34.42	17.51
HAZARDOUS/TOXIC WASTE		
PROJECTS		
GROUP 2 - C & D.....	\$ 34.12	17.51
HAZARDOUS/TOXIC WASTE		
PROJECTS		
GROUP 3 - C & D.....	\$ 30.70	17.51
HAZARDOUS/TOXIC WASTE		
PROJECTS		
GROUP 4 - C & D.....	\$ 27.08	17.51
HAZARDOUS/TOXIC WASTE		
PROJECTS		
GROUP 5 - C & D.....	\$ 23.97	17.51
ALL OTHER WORK		
GROUP 1.....	\$ 31.29	17.51
ALL OTHER WORK		
GROUP 2.....	\$ 31.02	17.51

ALL OTHER WORK

GROUP 3.....\$ 27.91 17.51
ALL OTHER WORK

GROUP 4.....\$ 24.62 17.51
ALL OTHER WORK

GROUP 5.....\$ 21.79 17.51

GROUP 1 - Rig, Pile Driver or Caisson Type; & Rig, Pile Hydraulic Unit Attached

GROUP 2 - Asphalt Heater Planer; Backfiller with Drag Attachment; Backhoe; Backhoe with Shear attached; Backhoe-Rear Pivotal Swing; Batch Plant-Central Mix Concrete; Batch Plant, Portable concrete; Berm Builder-Automatic; Boat Derrick; Boat-Tug; Boring Machine Attached to Tractor; Bullclam; Bulldozer; C.M.I. Road Builder & Similar Type; Cable Placer & Layer; Carrier-Straddle; Carryall-Scraper or Scoop; Chicago Boom; Compactor with Blade Attached; Concrete Saw (Vermeer or similar type); Concrete Spreader Finisher; Combination, Bidwell Machine; Crane; Crane-Electric Overhead; Crane-Rough Terrain; Crane-Side Boom; Crane-Truck; Crane-Tower; Derrick-Boom; Derrick-Car; Digger-Wheel (Not trencher or road widener); Double Nine; Drag Line; Dredge; Drill-Kenny or Similar Type; Easy Pour Median Barrier Machine (or similar type); Electromatic; Frankie Pile; Gradall; Grader; Gurry; Self-Propelled; Heavy Equipment Robotics Operator/Mechanic; Hoist-Monorail; Hoist-Stationary & Mobile Tractor; Hoist, 2 or 3 drum; Horizontal Directional Drill Operator; Jackall; Jumbo Machine; Kocal & Kuhlman; Land-Seagoing Vehicle; Loader, Elevating; Loader, Front End; Loader, Skid Steer; Locomotive; Mechanic/Welder; Metro Chip Harvester with Boom; Mucking Machine; Paver-Asphalt Finishing Machine; Paver-Road Concrete; Paver-Slip Form (C.M.I. or similar); Place Crete Machine with Boom; Post Driver (Carrier mounted); Power Driven Hydraulic Pump & Jack (When used in Slip Form or Lift Slab Construction); Pump Crete Machine; Regulator-Ballast; Hydraulic Power Unit not attached to Rig for Pile Drillings; Rigs-Drilling; Roto Mill or similar Full Lane (8' Wide & Over); Roto Mill or similar type (Under 8'); Shovel; Slip Form Curb Machine; Speedwing; Spikemaster; Stonecrusher; Tie Puller & Loader; Tie Tamper; Tractor-Double Boom; Tractor with Attachments; Truck-Boom; Truck-Tire; Trench Machine; Tunnel Machine (Mark 21 Java or similar); & Whirley (or similar type)

GROUP 3 - Asphalt Plant; Bending Machine (Pipeline or similar type); Boring machine, Motor Driven; Chip Harvester without Boom; Cleaning Machine, Pipeline Type; Coating Machine, Pipeline Type; Compactor; Concrete Belt Placer; Concrete Finisher; Concrete Planer or Asphalt; Concrete Spreader; Elevator; Fork Lift (Home building only); Fork lift & Lulls; Fork Lift Walk Behind (Hoisting over 1 buck

high); Form Line Machine; Grease Truck operator; Grout Pump; Gunnite Machine; Horizontal Directional Drill Locator; Single Drum Hoist with or without Tower; Huck Bolting Machine; Hydraulic Scaffold (Hoisting building materials); Paving Breaker (Self-propelled or Ridden); Pipe Dream; Pot Fireperson (Power Agitated); Refrigeration Plant; Road Widener; Roller; Sasgen Derrick; Seeding Machine; Soil Stabilizer (Pump type); Spray Cure Machine, Self-Propelled; Straw Blower Machine; Sub-Grader; Tube Finisher or Broom C.M.I. or similar type; & Tugger Hoist

GROUP 4 - Air Curtain Destructor & Similar Type; Batch Plant-Job Related; Boiler Operator; Compressor; Conveyor; Curb Builder, self-propelled; Drill Wagon; Generator Set; Generator-Steam; Heater-Portable Power; Hydraulic Manipulator Crane; Jack-Hydraulic Power driven; Jack-Hydraulic (Railroad); Ladavator; Minor Machine Operator; Mixer-Concrete; Mulching Machine; Pin Puller; Power Broom; Pulverizer; Pump; Road Finishing Machine (Pull Type); Saw-Concrete-Self-Propelled (Highway Work); Signal Person; Spray Cure Machine-Motor Powered; Stump Cutter; Tractor; Trencher Form; Water Blaster; Steam Jenny; Syphon; Vibrator-Gasoline; & Welding Machine

GROUP 5 - Brakeperson; Fireperson; & Oiler

IRON0017-002 05/01/2015

ASHTABULA (North of Route 6, starting at the Geauga County Line, proceeding east to State Route 45), CUYAHOGA, ERIE (Eastern 2/3), GEAUGA, HURON (East of a line drawn from the north border through Monroeville & Willard), LAKE, LORAIN, MEDINA (North of Old Rte. #224), PORTAGE (West of a line from Middlefield to Shalersville to Deerfield), and SUMMIT (North of Old Rte. #224, including city limits of Barberton) COUNTIES

	Rates	Fringes
IRONWORKER		
Ornamental, Reinforcing, & Structural.....	\$ 31.30	22.01

IRON0017-010 05/01/2015

ASHTABULA (Eastern part from Lake Erie on the north to route #322 on the south to include Conneaut, Kingsville, Sheffield, Denmark, Dorset, Cherry Valley, Wayne, Monroe, Pierpont, Richmond, Andover & Williamsfield Townships)

	Rates	Fringes
IRONWORKER		
Structural, including metal building erection &		

Reinforcing.....\$ 31.30 22.01

* IRON0044-002 06/01/2015

CLINTON (South of a line drawn from Blanchester to Lynchburg),
HAMILTON, HIGHLAND (Excluding eastern one-fifth & portion of
county inside lines drawn from Marshall to Lynchburg from the
northern county line through E. Monroe to Marshall) & WARREN
(South of a line drawn from Blanchester through Morrow to the
west county line)

Rates Fringes

IRONWORKER

Fence Erector.....\$ 23.64 19.40
Ornamental; Structural.....\$ 26.27 19.40

* IRON0055-003 07/01/2015

CRAWFORD (Area Between lines drawn from where Hwy #598 & #30
meet through N. Liberty to the northern border & from said Hwy
junction point due west to the border), DEFIANCE (S. of a line
drawn from where Rte. #66 meets the northern line through
Independence to the eastern county border), ERIE (Western 1/3),
FULTON, HANCOCK, HARDIN (North of a line drawn from Maysville
to a point 4 miles south of the northern line on the eastern
line), HENRY, HURON (West of a line drawn from the northern
border through Monroeville & Willard), LUCAS, OTTAWA, PUTNAM
(East of a line drawn from the northern border down through
Miller City to where #696 meets the southern border), SANDUSKY,
SENECA, WILLIAMS (East of a line drawn from Pioneer through
Stryker to the southern border), WOOD & WYANDOT (North of Rte.
#30)

Rates Fringes

IRONWORKER

Fence Erector.....\$ 20.00 20.13
Flat Road Mesh.....\$ 20.75 18.00
Tunnels & Caissons Under
Pressure.....\$ 28.50 18.00
All Other Work.....\$ 29.12 21.47

IRON0147-002 06/01/2015

ALLEN (Northern half), DEFIANCE (Northern part, excluding south
of a line drawn from where Rte. #66 meets the northern line
through Independence to the eastern county border), MERCER
(Northern half), PAULDING, PUTNAM (Western part, excluding east
of a line drawn from the northern border down through Miller
City to where #696 meets the southern border), VAN WERT, and
WILLIAMS (Western part, excluding east of a line drawn from
Pioneer through Stryker to the southern border) COUNTIES

	Rates	Fringes
IRONWORKER.....	\$ 25.39	20.64

IRON0172-002 06/01/2015

CHAMPAIGN (Eastern one-third), CLARK (Eastern one-fourth), COSHOCTON (West of a line beginning at the northwestern county line going through Walhonding & Tunnel Hill to the southern county line), CRAWFORD (South of Rte. #30), DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, HARDIN (Excluding a line drawn from Roundhead to Maysville), HIGHLAND (Eastern one-fifth), HOCKING, JACKSON (Northern half), KNOX, LICKING, LOGAN (Eastern one-third), MADISON, MARION, MORROW, MUSKINGUM (West of a line starting at Adams Mill going to Adamsville & going from Adamsville through Blue Rock to the southern border), PERRY, PICKAWAY, PIKE (Northern half), ROSS, UNION, VINTON and WYANDOT (South of Rte. #30) COUNTIES

	Rates	Fringes
IRONWORKER.....	\$ 28.12	19.14

* IRON0207-004 06/01/2015

ASHTABULA (Southern part starting at the Geauga County line), COLUMBIANA (E. of a line from Damascus to Highlandtown), MAHONING (N. of Old Route #224), PORTAGE (E. of a line from Middlefield to Shalersville to Deerfield) & TRUMBULL

	Rates	Fringes
IRONWORKER		
Layout; Sheeter.....	\$ 29.06	22.70
Ornamental; Reinforcing;		
Structural.....	\$ 28.06	22.70

IRON0290-002 06/01/2015

ALLEN (Southern half), AUGLAIZE, BUTLER (North of a line drawn from east to the west county line going through Oxford, Darrtown & Woodsdale), CHAMPAIGN (Excluding east of a line drawn from Catawla to the point where #68 intersects the northern county line), CLARK (Western two-thirds), CLINTON (Excluding south of a line drawn from Blanchester to Lynchburg), DARKE, GREENE, HIGHLAND (Inside lines drawn from Marshall to Lynchburg & from the northern county line through East Monroe to Marshall), LOGAN (West of a line drawn from West Liberty to where the northern county line meets the western county line of Hardin), MERCER (Southern half), MIAMI, MONTGOMERY, PREBLE, SHELBY & WARREN (Excluding south of a line drawn from Blanchester through Morrow to the western county line) COUNTIES

	Rates	Fringes
IRONWORKER.....	\$ 27.00	20.23

IRON0372-002 06/01/2015

ADAMS (Western Part), BROWN, BUTLER (Southern Part), CLERMONT, CLINTON (South of a line drawn from Blanchester to Lynchburg), HAMILTON, HIGHLAND (Excluding eastern one-fifth & portion of county inside lines drawn from Marshall to Lynchburg from the northern county line through E. Monroe to Marshall) and WARREN (South of a line drawn from Blanchester through Morrow to the west county line) COUNTIES

	Rates	Fringes
IRONWORKER, REINFORCING		
Beyond 30-mile radius of		
Hamilton County Courthouse..	\$ 27.25	19.33
Up to & including 30-mile		
radius of Hamilton County		
Courthouse.....	\$ 27.00	19.33

IRON0549-003 12/01/2012

BELMONT, GUERNSEY, HARRISON, JEFFERSON, MONROE & MUSKINGUM (Excluding portion west of a line starting at Adams Mill going to Adamsville and going from Adamsville through Blue Rock to the south border)

	Rates	Fringes
IRONWORKER.....	\$ 30.00	16.49

IRON0550-004 05/01/2015

ASHLAND, CARROLL, COLUMBIANA (W. of a line from Damascus to Highlandtown), COSHOCTON (E. of a line beginning at NW Co. line going through Walhonding & Tunnel Hill to the South Co. line), HOLMES, HURON (S. of Old Rte. #224), MAHONING (S. of Old Rte. #224), MEDINA (S. of Old Rte. #224), PORTAGE (S. of Old Rte. #224), RICHLAND, STARK, SUMMIT (S. of Old Rte. #224, Excluding city limits of Barberton), TUSCARAWAS, & WAYNE

	Rates	Fringes
Ironworkers:Structural,		
Ornamental and Reinforcing.....	\$ 26.66	18.36

* IRON0769-004 06/01/2015

ADAMS (Eastern Half), GALLIA, JACKSON (Southern Half), LAWRENCE & SCIOTO

	Rates	Fringes
IRONWORKER.....	\$ 31.33	22.81

IRON0787-003 06/01/2013

ATHENS, MEIGS, MORGAN, NOBLE, and WASHINGTON COUNTIES

	Rates	Fringes
IRONWORKER.....	\$ 30.87	19.15

LABO0265-008 05/01/2014

	Rates	Fringes
LABORER		
ASHTABULA, ERIE, HURON, LORAIN, LUCAS, MAHONING, MEDINA, OTTAWA, PORTAGE, SANDUSKY, STARK, SUMMIT, TRUMBULL & WOOD COUNTIES		
GROUP 1.....	\$ 28.15	9.80
GROUP 2.....	\$ 28.32	9.80
GROUP 3.....	\$ 28.65	9.80
GROUP 4.....	\$ 29.10	9.80
CUYAHOGA AND GEAUGA COUNTIES ONLY: SEWAGE PLANTS, WASTE PLANTS, WATER TREATMENT FACILITIES, PUMPING STATIONS, & ETHANOL PLANTS		
CONSTRUCTION.....	\$ 30.76	9.80
CUYAHOGA, GEAUGA & LAKE COUNTIES		
GROUP 1.....	\$ 29.38	9.80
GROUP 2.....	\$ 29.55	9.80
GROUP 3.....	\$ 29.88	9.80
GROUP 4.....	\$ 30.33	9.80
REMAINING COUNTIES OF OHIO		
GROUP 1.....	\$ 27.72	9.80
GROUP 2.....	\$ 27.89	9.80
GROUP 3.....	\$ 28.22	9.80
GROUP 4.....	\$ 28.67	9.80

LABORER CLASSIFICATIONS

GROUP 1 - Asphalt Laborer; Carpenter Tender; Concrete Curing
Applicator; Dump Man (Batch Truck); Guardrail and Fence
Installer; Joint Setter; Laborer (Construction); Landscape
Laborer; Mesh Handlers & Placer; Right-of-way Laborer;
Riprap Laborer & Grouter; Scaffold Erector; Seal Coating;
Surface Treatment or Road Mix Laborer; Sign Installer;
Slurry Seal; Utility Man; Bridge Man; Handyman;
Waterproofing Laborer; Flagperson; Hazardous Waste (level
D); Diver Tender; Zone Person & Traffic Control

GROUP 2 - Asphalt Raker; Concrete Puddler; Kettle Man Pipeline); Machine Driven Tools (Gas, Electric, Air); Mason Tender; Brick Paver; Mortar Mixer; Power Buggy or Power Wheelbarrow; Sheeting & Shoring Man; Surface Grinder Man; Plastic Fusing Machine Operator; Pug Mill Operator; & Vacuum Devices (wet or dry); Rodding Machine Operator; Diver; Screwman or Paver; Screed Person; Water Blast, Hand Held Wand; Pumps 4" & Under (Gas, Air or Electric) & Hazardous Waste (level C); Air Track and Wagon Drill; Bottom Person; Cofferdam (below 25 ft. deep); Concrete Saw Person; Cutting with Burning Torch; Form Setter; Hand Spiker (Railroad); Pipelayer; Tunnel Laborer (without air) & Caisson; Underground Person (working in Sewer and Waterline, Cleaning, Repairing & Reconditioning); Sandblaster Nozzle Person; & Hazardous Waste (level B)

GROUP 3 - Blaster; Mucker; Powder Person; Top Lander; Wrencher (Mechanical Joints & Utility Pipeline); Yarnier; Hazardous Waste (level A); Concrete Specialist; Concrete Crew in Tunnels (With Air-pressurized - \$1.00 premium); Curb Setter & Cutter; Grade Checker; Utility Pipeline Tapper; Waterline; and Caulker

GROUP 4 - Miner (With Air-pressurized - \$1.00 premium); & Gunite Nozzle Person

TUNNEL LABORER WITH AIR-PRESSURIZED ADD \$1.00 TO BASE RATE

SIGNAL PERSON WILL RECEIVE THE RATE EQUAL TO THE RATE PAID THE LABORER CLASSIFICATION FOR WHICH HE OR SHE IS SIGNALING.

PAIN0006-002 05/01/2015

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, LORAIN, PORTAGE (N. of the East-West Turnpike) & SUMMIT (N. of the East-West Turnpike)

	Rates	Fringes
PAINTER		
COMMERCIAL NEW WORK;		
REMODELING; & RENOVATIONS		
GROUP 1.....	\$ 27.57	13.98
GROUP 2.....	\$ 27.97	13.98
GROUP 3.....	\$ 28.27	13.98
GROUP 4.....	\$ 29.27	13.98
COMMERCIAL REPAINT		
GROUP 1.....	\$ 27.57	13.98
GROUP 2.....	\$ 27.97	13.98
GROUP 3.....	\$ 28.27	13.98

PAINTER CLASSIFICATIONS - COMMERCIAL NEW WORK; REMODELING; & RENOVATIONS

GROUP 1 - Brush; & Roller

GROUP 2 - Sandblasting & Buffing

GROUP 3 - Spray Painting; Closed Steel Above 55 feet; Bridges
& Open Structural Steel; Tanks - Water Towers; Bridge
Painters; Bridge Riggers; Containment Builders

GROUP 4 - Bridge Blaster

PAINTER CLASSIFICATIONS - COMMERCIAL REPAINT

GROUP 1 - Brush; & Roller

GROUP 2 - Sandblasting & Buffing

GROUP 3 - Spray Painting

* PAIN0007-002 07/01/2015

FULTON, HENRY, LUCAS, OTTAWA (Excluding Allen, Bay, Bono,
Catawba Island, Clay Center, Curtice, Danbury, Eagle Beach,
Elliston, Elmore, Erie, Fishback, Gem Beach & Genova) & WOOD

	Rates	Fringes
PAINTER		
NEW COMMERCIAL WORK		
GROUP 1.....	\$ 25.67	15.01
GROUP 2.....	\$ 25.22	15.01
GROUP 3.....	\$ 25.47	15.01
GROUP 4.....	\$ 25.57	15.01
GROUP 5.....	\$ 25.67	15.01
GROUP 6.....	\$ 25.97	15.01
GROUP 7.....	\$ 25.97	15.01
GROUP 8.....	\$ 26.27	15.01
GROUP 9.....	\$ 24.81	13.22

REPAINT IS 90% OF JR

PAINTER CLASSIFICATIONS

GROUP 1 - Brush; Spray & Sandblasting Pot Tender

GROUP 2 - Refineries & Refinery Tanks; Surfaces 30 ft. or
over where material is applied to or labor performed on
above ground level (exterior), floor level (interior)

GROUP 3 - Swing Stage & Chair

GROUP 4 - Lead Abatement

GROUP 5 - All Methods of Spray

GROUP 6 - Solvent-Based Catalized Epoxy Materials of 2 or
More Component Materials, to include Solvent-Based

Conversion Varnish (excluding water based)

GROUP 7 - Spray Solvent Based Material; Sand & Abrasive
Blasting

GROUP 8 - Towers; Tanks; Bridges; Stacks Over 30 Feet

GROUP 9 - Epoxy Spray (excluding water based)

PAIN0012-008 05/01/2015

BUTLER COUNTY

	Rates	Fringes
PAINTER		
GROUP 1.....	\$ 20.73	9.11
GROUP 2.....	\$ 23.39	9.11
GROUP 3.....	\$ 23.89	9.11
GROUP 4.....	\$ 24.14	9.11
GROUP 5.....	\$ 24.39	9.11

PAINTER CLASSIFICATIONS

GROUP 1: Bridge Equipment Tender; Bridge/Containment Builder

GROUP 2: Brush & Roller

GROUP 3: Spray

GROUP 4: Sandblasting; & Waterblasting

GROUP 5: Elevated Tanks; Steeplejack Work; Bridge; & Lead
Abatement

PAIN0012-010 05/01/2015

BROWN, CLERMONT, CLINTON, HAMILTON & WARREN

	Rates	Fringes
PAINTER		
HEAVY & HIGHWAY BRIDGES-		
GUARDRAILS-LIGHTPOLES-		
STRIPING		
Bridge Equipment Tender and Containment Builder....	\$ 20.73	9.11
Bridges when highest point of clearance is 60 feet or more; & Lead Abatement Projects.....	\$ 24.39	9.11
Brush & Roller.....	\$ 23.39	9.11

Sandblasting & Hopper		
Tender; Water Blasting.....	\$ 24.14	9.11
Spray.....	\$ 23.89	9.11

PAIN0012-014 05/01/2014

DELAWARE, FAIRFIELD, FAYETTE, FRANKLIN, MADISON, PICKAWAY, ROSS
& UNION

	Rates	Fringes
PAINTER		
Bridges.....	\$ 34.13	10.56
Brush; Roller.....	\$ 24.65	10.56
Sandblasting; Steamcleaning; Waterblasting (3500 PSI or Over)& Hazardous Work.....	\$ 25.35	10.56
Spray.....	\$ 25.15	10.56
Stacks; Tanks; & Towers.....	\$ 28.16	10.56
Structural Steel & Swing Stage.....	\$ 24.95	10.56

PAIN0093-001 12/01/2014

ATHENS, GUERNSEY, HOCKING, MONROE, MORGAN, NOBLE and
WASHINGTON COUNTIES

	Rates	Fringes
PAINTER		
Bridges; Locks; Dams; Tension Towers; & Energized Substations.....	\$ 30.19	14.50
Power Generating Facilities.	\$ 27.04	14.50

PAIN0249-002 05/01/2015

CLARK, DARKE, GREENE, MIAMI, MONTGOMERY & PREBLE

	Rates	Fringes
PAINTER		
GROUP 1 - Brush & Roller....	\$ 23.24	6.38
GROUP 2 - Swing, Scaffold Bridges; Structural Steel; Open Acid Tank; High Tension Electrical Equipment; & Hot Pipes.....	\$ 23.24	6.38
GROUP 3 - Spray; Sandblast; Steamclean; Lead Abatement.....	\$ 23.99	6.38
GROUP 4 - Steeplejack Work..	\$ 24.19	6.38
GROUP 5 - Coal Tar.....	\$ 24.74	6.38
GROUP 6 - Bridge Equipment		

Tender & or Containment Builder.....	\$ 26.48	6.38
GROUP 7 - Tanks, Stacks & Towers.....	\$ 26.88	6.38
GROUP 8 - Bridge Blaster, Rigger.....	\$ 32.85	6.38

PAIN0356-002 09/01/2009

KNOX, LICKING, MUSKINGUM, and PERRY

	Rates	Fringes
PAINTER		
Bridge Equipment Tenders and Containment Builders....	\$ 27.93	7.25
Bridges; Blasters; and Riggers.....	\$ 34.60	7.25
Brush and Roller.....	\$ 20.93	7.25
Sandblasting; Steam Cleaning; Waterblasting; and Hazardous Work.....	\$ 25.82	7.25
Spray.....	\$ 21.40	7.25
Structural Steel and Swing Stage.....	\$ 25.42	7.25
Tanks; Stacks; and Towers...	\$ 28.63	7.25

PAIN0438-002 12/01/2014

BELMONT, HARRISON and JEFFERSON COUNTIES

	Rates	Fringes
PAINTER		
Bridges, Locks, Dams, Tension Towers & Energized Substations.....	\$ 30.88	13.98
Power Generating Facilities.	\$ 27.73	13.98

PAIN0476-001 06/01/2015

COLUMBIANA, MAHONING, and TRUMBULL COUNTIES

	Rates	Fringes
PAINTER		
GROUP 1.....	\$ 24.97	11.73
GROUP 2.....	\$ 26.97	11.73
GROUP 3.....	\$ 25.18	11.73
GROUP 4.....	\$ 25.62	11.73
GROUP 5.....	\$ 25.62	11.73
GROUP 6.....	\$ 25.87	11.73
GROUP 7.....	\$ 26.97	11.73

PAINTER CLASSIFICATIONS:

GROUP 1: Painters, Brush & Roller

GROUP 2: Bridges

GROUP 3: Structural Steel

GROUP 4: Spray, Except Bar Joist/Deck

GROUP 5: Epoxy/Mastic; Spray- Bar Joist/Deck; Working Above
50 Feet; and Swingstages

GROUP 6: Tanks; Sandblasting

GROUP 7: Towers; Stacks

PAIN0555-002 06/01/2014

ADAMS, HIGHLAND, JACKSON, PIKE & SCIOTO

	Rates	Fringes
PAINTER		
GROUP 1.....	\$ 29.26	13.67
GROUP 2.....	\$ 30.58	13.67
GROUP 3.....	\$ 31.91	13.67
GROUP 4.....	\$ 34.49	13.67

PAINTER CLASSIFICATIONS

GROUP 1 - Containment Builder

GROUP 2 - Brush; Roller; Power Tools, Under 40 feet

GROUP 3 - Sand Blasting; Spray; Steam Cleaning; Pressure
Washing; Epoxy & Two Component Materials; Lead Abatement;
Hazardous Waste; Toxic Materials; Bulk & Storage Tanks of
25,000 Gallon Capacity or More; Elevated Tanks

GROUP 4 - Stacks; Bridges

PAIN0603-002 06/01/2012

CARROLL, COSHOCTON, HOLMES, STARK, TUSCARAWAS & WAYNE

	Rates	Fringes
PAINTER		
Bridges; Towers, Poles & Stacks; Sandblasting Steel; Structural Steel & Metalizing.....	\$ 20.71	11.00
Brush & Roller.....	\$ 20.00	11.00
Spray; Tank Interior & Exterior.....	\$ 20.53	11.00

PAIN0639-001 05/01/2011

	Rates	Fringes
Sign Painter & Erector.....	\$ 20.61	3.50+a+b+c

FOOTNOTES: a. 7 Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; Christmas Day & 1 Floating Day

b. Vacation Pay: After 1 year's service - 5 days' paid vacation; After 2, but less than 10 years' service - 10 days' paid vacation; After 10, but less than 20 years' service - 15 days' paid vacation; After 20 years' service - 20 days' paid vacation

c. Funeral leave up to 3 days maximum paid leave for death of mother, father, brother, sister, spouse, child, mother-in-law, father-in-law, grandparent and inlaw provided employee attends funeral

PAIN0788-002 06/01/2015

ASHLAND, CRAWFORD, ERIE, HANCOCK, HURON, MARION, MORROW, OTTAWA (Allen, Bay, Bono, Catawba Island, Clay Center, Curtice, Danbury, Eagle Beach, Elliston, Elmore, Erie, Fishback, Gem Beach & Genoa), RICHLAND, SANDUSKY, SENECA & WYANDOT

	Rates	Fringes
PAINTER		
Brush & Roller.....	\$ 23.47	11.55
Structural Steel.....	\$ 25.07	11.55

WINTER REPAINT: Between December 1 to March 31 - 90%JR

\$.50 PER HOUR SHALL BE ADDED TO THE RATE OF PAY FOR THE CLASSIFICATION OF WORK:

While working swingstage, boatswain chair, needle beam and horizontal cable. While operating sprayguns, sandblasting, cobblasting and high pressure waterblasting (4000psi).

\$1.00 PER HOUR SHALL BE ADDED TO THE RATE OF PAY FOR THE CLASSIFICATION OF WORK:

For the application of catalized epoxy, including latex epoxy that is deemed hazardous, lead abatement, or for work or material where special precautions beyond normal work duties must be taken. For working on stacks, tanks, and towers over 40 feet in height.

PAIN0813-005 12/01/2008

GALLIA, LAWRENCE, MEIGS & VINTON

Rates	Fringes

PAINTER

Base Rate.....	\$ 24.83	10.00
Bridges, Locks, Dams &		
Tension Towers.....	\$ 27.83	10.00

PAIN0841-001 06/01/2015

MEDINA, PORTAGE (South of and including Ohio Turnpike), and
SUMMIT (South of and including Ohio Turnpike) COUNTIES

	Rates	Fringes
Painters:		
GROUP 1.....	\$ 24.88	12.97
GROUP 2.....	\$ 25.53	12.97
GROUP 3.....	\$ 25.63	12.97
GROUP 4.....	\$ 25.73	12.97
GROUP 5.....	\$ 26.13	12.97
GROUP 6.....	\$ 39.20	11.75
GROUP 7.....	\$ 26.13	12.97

PAINTER CLASSIFICATIONS:

GROUP 1 - Brush, Roller & Paperhanger

GROUP 2 - Epoxy Application

GROUP 3 - Swing Scaffold, Bosum Chair, & Window Jack

GROUP 4 - Spray Gun Operator of Any & All Coatings

GROUP 5 - Sandblast, Painting of Standpipes, etc. from
Scaffolds, Bridge Work and/or Open Structural Steel,
Standpipes and/or Water Towers

GROUP 6 - Public & Commerce Transportation, Steel or
Galvanized, Bridges, Tunnels & Related Support Items
(concrete)

GROUP 7 - Synthetic Exterior, Drywall Finisher and/or Taper,
Drywall Finisher and Follow-up Man Using Automatic Tools

* PAIN1020-002 07/01/2015

ALLEN, AUGLAIZE, CHAMPAIGN, DEFIANCE, HARDIN, LOGAN, MERCER,
PAULDING, PUTNAM, SHELBY, VAN WERT, and WILLIAMS COUNTIES

	Rates	Fringes
PAINTER		
Brush & Roller.....	\$ 23.48	11.65
Drywall Finishing & Taping..	\$ 22.38	11.65
Lead Abatement.....	\$ 25.23	11.65

Spray, Sandblasting Pressure Cleaning, & Refinery.....	\$ 24.23	11.65
Swing Stage, Chair, Spiders, & Cherry Pickers...	\$ 23.73	11.65
Wallcoverings.....	\$ 21.08	11.65

All surfaces 40 ft. or over where material is applied to or
labor performed on, above ground level (exterior), floor
level (interior) - \$.50 premium

Applying Coal Tar Products - \$1.00 premium

* PLUM0042-002 07/01/2015

ASHLAND, CRAWFORD, ERIE, HURON, KNOX, LORAIN, MORROW, RICHLAND
& WYANDOT

	Rates	Fringes
Plumber, Pipefitter, Steamfitter.....	\$ 31.45	20.21

PLUM0050-002 09/01/2013

DEFIANCE, FULTON, HANCOCK, HENRY, LUCAS, OTTAWA, PAULDING,
PUTNAM, SANDUSKY, SENECA, WILLIAMS & WOOD

	Rates	Fringes
Plumber, Pipefitter, Steamfitter.....	\$ 36.65	22.54

PLUM0055-003 05/04/2015

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, MEDINA (N. of Rte. #18 &
Smith Road) & SUMMIT (N. of Rte. #303, including the corporate
limits of the city of Hudson)

	Rates	Fringes
PLUMBER.....	\$ 34.90	22.58

PLUM0083-001 07/01/2013

BELMONT & MONROE (North of Rte. #78)

	Rates	Fringes
Plumber and Steamfitter.....	\$ 25.42	27.83

PLUM0094-002 05/01/2015

CARROLL (Nothern Half), STARK, and WAYNE COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER.....	\$ 33.83	16.84

PLUM0120-002 05/01/2014

ASHTABULA, CUYAHOGA, GEAUGA, LAKE, LORAIN (the C.E.I. Power House in Avon Lake), MEDINA (N. of Rte. #18) & SUMMIT (N. of #303)

	Rates	Fringes
PIPEFITTER.....	\$ 35.69	20.72

PLUM0162-002 06/01/2014

CHAMPAIGN, CLARK, CLINTON, DARKE, FAYETTE, GREENE, MIAMI, MONTGOMERY & PREBLE

	Rates	Fringes
Plumber, Pipefitter, Steamfitter.....	\$ 28.25	20.77

PLUM0168-002 06/01/2013

MEIGS, MONROE (South of Rte. #78), MORGAN (South of Rte. #78) & WASHINGTON

	Rates	Fringes
PLUMBER/PIPEFITTER.....	\$ 33.83	18.47

PLUM0189-002 06/01/2013

DELAWARE, FAIRFIELD, FRANKLIN, HOCKING, LICKING, MADISON, MARION, PERRY, PICKAWAY, ROSS & UNION

	Rates	Fringes
Plumber, Pipefitter, Steamfitter.....	\$ 34.08	20.06

PLUM0219-002 06/01/2013

MEDINA (Rte. #18 from eastern edge of Medina Co., west to eastern corporate limits of the city of Medina, & on the county road from the west corporate limits of Medina running due west to and through community of Risley to the western edge of Medina County - All territory south of this line), PORTAGE, and SUMMIT (S. of Rte. #303) COUNTIES

	Rates	Fringes
Plumber and Steamfitter.....	\$ 33.82	21.09

* PLUM0392-002 06/01/2015

BROWN, BUTLER, CLERMONT, HAMILTON & WARREN

	Rates	Fringes
PLUMBER/PIPEFITTER.....	\$ 30.83	19.39

PLUM0396-001 06/01/2014

COLUMBIANA (Excluding Washington & Yellow Creek Townships & Liverpool Twp. - Secs. 35 & 36 - West of County Road #427), MAHONING and TRUMBULL COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER.....	\$ 32.56	18.40

PLUM0495-002 06/01/2014

CARROLL (Rose, Monroe, Union, Lee, Orange, Perry & Loudon Townships), COLUMBIANA (Washington & Yellow Creek Townships & Liverpool Township, Secs. 35 & 36, West of County Rd. #427), COSHOCTON, GUERNSEY, HARRISON, HOLMES, JEFFERSON, MORGAN (South to State Rte. #78 & from McConnelsville west on State Rte. #37 to the Perry County line), MUSKINGUM, NOBLE, and TUSCARAWAS COUNTIES

	Rates	Fringes
Plumber, Pipefitter, Steamfitter.....	\$ 30.42	20.06

PLUM0577-002 06/01/2014

ADAMS, ATHENS, GALLIA, HIGHLAND, JACKSON, LAWRENCE, PIKE, SCIOTO & VINTON

	Rates	Fringes
Plumber, Pipefitter, Steamfitter.....	\$ 26.80	21.88

PLUM0776-002 07/01/2013

ALLEN, AUGLAIZE, HARDIN, LOGAN, MERCER, SHELBY and VAN WERT COUNTIES

	Rates	Fringes
Plumber, Pipefitter, Steamfitter.....	\$ 32.20	20.24

TEAM0377-003 05/01/2012

STATEWIDE, EXCEPT CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
TRUCK DRIVER		
GROUP 1.....	\$ 23.38	13.18
GROUP 2.....	\$ 23.80	13.18

TRUCK DRIVER CLASSIFICATIONS

GROUP 1 - Asphalt Distributor; Batch; 4- Wheel Service;
4-Wheel Dump; Oil Distributor & Tandem

GROUP 2 - Tractor-Trailer Combination: Fuel; Pole Trailer;
Ready Mix; Semi-Tractor; & Asphalt Oil Spraybar Man When
Operated From Cab; 5 Axles & Over; Belly Dump; End Dump;
Articulated Dump; Heavy Duty Equipment; Low Boy; & Truck
Mechanic

TEAM0436-002 05/01/2014

CUYAHOGA, GEAUGA & LAKE

	Rates	Fringes
TRUCK DRIVER		
GROUP 1.....	\$ 26.15	14.85
GROUP 2.....	\$ 26.65	14.85

GROUP 1: Straight & Dump, Straight Fuel

GROUP 2: Semi Fuel, Semi Tractor, Euclids, Darts, Tank,
Asphalt Spreaders, Low Boys, Carry-All, Tourna-Rockers,
Hi-Lifts, Extra Long Trailers, Semi-Pole Trailers, Double
Hook-Up Tractor Trailers including Team Track & Railroad
Siding, Semi-Tractor & Tri-Axle Trailer, Tandem Tractor &
Tandem Trailer, Tag Along Trailer, Expandable Trailer or
Towing Requiring Road Permits, Ready-Mix (Agitator or
Non-Agitator), Bulk Concrete Driver, Dry Batch Truck,
Articulated End Dump

WELDERS - Receive rate prescribed for craft performing
operation to which welding is incidental.

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Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than "SU" or "UAVG" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the "SU" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a

new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

AMERICAN IRON AND STEEL ACKNOWLEDGEMENT

The Contractor acknowledges to and for the benefit of the City of _____ (“Purchaser”) and the State of Ohio (the “State”) that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund and/or Drinking Water State Revolving Fund that have statutory requirements commonly known as “American Iron and Steel;” that requires all of the iron and steel products used in the project to be produced in the United States (“American Iron and Steel Requirement”) including iron and steel products provided by the Contractor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the State. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney’s fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser). While the Contractor has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State.

Signature

Date

Name and Title of Authorized Signatory, Please Print or Type

Bidder’s Firm

- ☐ Check here if the WPCLF or WSRLA applicant will be requesting an individual waiver for non-American made iron and steel products. Please note that the waiver box does not need to be marked for nationwide waivers.



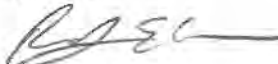
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

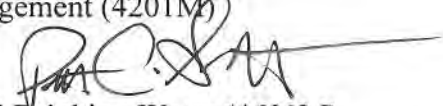
MAR 20 2014

OFFICE OF WATER

MEMORANDUM

SUBJECT: Implementation of American Iron and Steel provisions of P.L. 113-76,
Consolidated Appropriations Act, 2014

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Regions I - X

P.L. 113-76, Consolidated Appropriations Act, 2014 (Act), includes an "American Iron and Steel (AIS)" requirement in section 436 that requires Clean Water State Revolving Loan Fund (CWSRF) and Drinking Water State Revolving Loan Fund (DWSRF) assistance recipients to use iron and steel products that are produced in the United States for projects for the construction, alteration, maintenance, or repair of a public water system or treatment works if the project is funded through an assistance agreement executed beginning January 17, 2014 (enactment of the Act), through the end of Federal Fiscal Year 2014.

Section 436 also sets forth certain circumstances under which EPA may waive the AIS requirement. Furthermore, the Act specifically exempts projects where engineering plans and specifications were approved by a State agency prior to January 17, 2014.

The approach described below explains how EPA will implement the AIS requirement. The first section is in the form of questions and answers that address the types of projects that must comply with the AIS requirement, the types of products covered by the AIS requirement, and compliance. The second section is a step-by-step process for requesting waivers and the circumstances under which waivers may be granted.

Implementation

The Act states:

Sec. 436. (a)(1) None of the funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12) shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States.

(2) In this section, the term “iron and steel products” means the following products made primarily of iron or steel: lined or unlined pipes and fittings, manhole covers and other municipal castings, hydrants, tanks, flanges, pipe clamps and restraints, valves, structural steel, reinforced precast concrete, and construction materials.

(b) Subsection (a) shall not apply in any case or category of cases in which the Administrator of the Environmental Protection Agency (in this section referred to as the “Administrator”) finds that—

(1) applying subsection (a) would be inconsistent with the public interest;

(2) iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or

(3) inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

(c) If the Administrator receives a request for a waiver under this section, the Administrator shall make available to the public on an informal basis a copy of the request and information available to the Administrator concerning the request, and shall allow for informal public input on the request for at least 15 days prior to making a finding based on the request. The Administrator shall make the request and accompanying information available by electronic means, including on the official public Internet Web site of the Environmental Protection Agency.

(d) This section shall be applied in a manner consistent with United States obligations under international agreements.

(e) The Administrator may retain up to 0.25 percent of the funds appropriated in this Act for the Clean and Drinking Water State Revolving Funds for carrying out

the provisions described in subsection (a)(1) for management and oversight of the requirements of this section.

(f) This section does not apply with respect to a project if a State agency approves the engineering plans and specifications for the project, in that agency's capacity to approve such plans and specifications prior to a project requesting bids, prior to the date of the enactment of this Act.

The following questions and answers provide guidance for implementing and complying with the AIS requirements:

Project Coverage

1) What classes of projects are covered by the AIS requirement?

All treatment works projects funded by a CWSRF assistance agreement, and all public water system projects funded by a DWSRF assistance agreement, from the date of enactment through the end of Federal Fiscal Year 2014, are covered. The AIS requirements apply to the entirety of the project, no matter when construction begins or ends. Additionally, the AIS requirements apply to all parts of the project, no matter the source of funding.

2) Does the AIS requirement apply to nonpoint source projects or national estuary projects?

No. Congress did not include an AIS requirement for nonpoint source and national estuary projects unless the project can also be classified as a 'treatment works' as defined by section 212 of the Clean Water Act.

3) Are any projects for the construction, alteration, maintenance, or repair of a public water system or treatment works excluded from the AIS requirement?

Any project, whether a treatment works project or a public water system project, for which engineering plans and specifications were approved by the responsible state agency prior to January 17, 2014, is excluded from the AIS requirements.

4) What if the project does not have approved engineering plans and specifications but has signed an assistance agreement with a CWSRF or DWSRF program prior to January 17, 2014?

The AIS requirements do not apply to any project for which an assistance agreement was signed prior to January 17, 2014.

5) What if the project does not have approved engineering plans and specifications, but bids were advertised prior to January 17, 2014 and an assistance agreement was signed after January 17, 2014?

If the project does not require approved engineering plans and specifications, the bid advertisement date will count in lieu of the approval date for purposes of the exemption in section 436(f).

6) What if the assistance agreement that was signed prior to January 17, 2014, only funded a part of the overall project, where the remainder of the project will be funded later with another SRF loan?

If the original assistance agreement funded any construction of the project, the date of the original assistance agreement counts for purposes of the exemption. If the original assistance agreement was only for planning and design, the date of that assistance agreement will count for purposes of the exemption only if there is a written commitment or expectation on the part of the assistance recipient to fund the remainder of the project with SRF funds.

7) What if the assistance agreement that was signed prior to January 17, 2014, funded the first phase of a multi-phase project, where the remaining phases will be funded by SRF assistance in the future?

In such a case, the phases of the project will be considered a single project if all construction necessary to complete the building or work, regardless of the number of contracts or assistance agreements involved, are closely related in purpose, time and place. However, there are many situations in which major construction activities are clearly undertaken in phases that are distinct in purpose, time, or place. In the case of distinct phases, projects with engineering plans and specifications approval or assistance agreements signed prior to January 17, 2014 would be excluded from AIS requirements while those approved/signed on January 17, 2014, or later would be covered by the AIS requirements.

8) What if a project has split funding from a non-SRF source?

Many States intend to fund projects with “split” funding, from the SRF program and from State or other programs. Based on the Act language in section 436, which requires that American iron and steel products be used in any project for the construction, alteration, maintenance, or repair of a public water system or treatment works receiving SRF funding between and including January 17, 2014 and September 30, 2014, any project that is funded in whole or in part with such funds must comply with the AIS requirement. A “project” consists of all construction necessary to complete the building or work regardless of the number of contracts or assistance agreements involved so long as all contracts and assistance agreements awarded are closely related in purpose, time and place. This precludes the intentional splitting of SRF projects into separate and smaller contracts or assistance agreements to avoid AIS coverage on some portion of a larger

project, particularly where the activities are integrally and proximately related to the whole. However, there are many situations in which major construction activities are clearly undertaken in separate phases that are distinct in purpose, time, or place, in which case, separate contracts or assistance agreement for SRF and State or other funding would carry separate requirements.

9) What about refinancing?

If a project began construction, financed from a non-SRF source, prior to January 17, 2014, but is refinanced through an SRF assistance agreement executed on or after January 17, 2014 and prior to October 1, 2014, AIS requirements will apply to all construction that occurs on or after January 17, 2014, through completion of construction, unless, as is likely, engineering plans and specifications were approved by a responsible state agency prior to January 17, 2014. There is no retroactive application of the AIS requirements where a refinancing occurs for a project that has completed construction prior to January 17, 2014.

10) Do the AIS requirements apply to any other EPA programs, besides the SRF program, such as the Tribal Set-aside grants or grants to the Territories and DC?

No, the AIS requirement only applies to funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12)

Covered Iron and Steel Products

11) What is an iron or steel product?

For purposes of the CWSRF and DWSRF projects that must comply with the AIS requirement, an iron or steel product is one of the following made primarily of iron or steel that is permanently incorporated into the public water system or treatment works:

- Lined or unlined pipes or fittings;
- Manhole Covers;
- Municipal Castings (defined in more detail below);
- Hydrants;
- Tanks;
- Flanges;
- Pipe clamps and restraints;
- Valves;
- Structural steel (defined in more detail below);
- Reinforced precast concrete; and
- Construction materials (defined in more detail below).

12) What does the term ‘primarily iron or steel’ mean?

‘Primarily iron or steel’ places constraints on the list of products above. For one of the listed products to be considered subject to the AIS requirements, it must be made of greater than 50% iron or steel, measured by cost. The cost should be based on the material costs.

13) Can you provide an example of how to perform a cost determination?

For example, the iron portion of a fire hydrant would likely be the bonnet, body and shoe, and the cost then would include the pouring and casting to create those components. The other material costs would include non-iron and steel internal workings of the fire hydrant (i.e., stem, coupling, valve, seals, etc). However, the assembly of the internal workings into the hydrant body would not be included in this cost calculation. If one of the listed products is not made primarily of iron or steel, United States (US) provenance is not required. An exception to this definition is reinforced precast concrete, which is addressed in a later question.

14) If a product is composed of more than 50% iron or steel, but is not listed in the above list of items, must the item be produced in the US? Alternatively, must the iron or steel in such a product be produced in the US?

The answer to both question is no. Only items on the above list must be produced in the US. Additionally, the iron or steel in a non-listed item can be sourced from outside the US.

15) What is the definition of steel?

Steel means an alloy that includes at least 50 percent iron, between .02 and 2 percent carbon, and may include other elements. Metallic elements such as chromium, nickel, molybdenum, manganese, and silicon may be added during the melting of steel for the purpose of enhancing properties such as corrosion resistance, hardness, or strength. The definition of steel covers carbon steel, alloy steel, stainless steel, tool steel and other specialty steels.

16) What does ‘produced in the United States’ mean?

Production in the United States of the iron or steel products used in the project requires that all manufacturing processes, including application of coatings, must take place in the United States, with the exception of metallurgical processes involving refinement of steel additives. All manufacturing processes includes processes such as melting, refining, forming, rolling, drawing, finishing, fabricating and coating. Further, if a domestic iron and steel product is taken out of the US for any part of the manufacturing process, it becomes foreign source material. However, raw materials such as iron ore, limestone and iron and steel scrap are not covered by the AIS requirement, and the

material(s), if any, being applied as a coating are similarly not covered. Non-iron or steel components of an iron and steel product may come from non-US sources. For example, for products such as valves and hydrants, the individual non-iron and steel components do not have to be of domestic origin.

17) Are the raw materials used in the production of iron or steel required to come from US sources?

No. Raw materials, such as iron ore, limestone, scrap iron, and scrap steel, can come from non-US sources.

18) If an above listed item is primarily made of iron or steel, but is only at the construction site temporarily, must such an item be produced in the US?

No. Only the above listed products made primarily of iron or steel, permanently incorporated into the project must be produced in the US. For example trench boxes, scaffolding or equipment, which are removed from the project site upon completion of the project, are not required to be made of U.S. Iron or Steel.

19) What is the definition of ‘municipal castings’?

Municipal castings are cast iron or steel infrastructure products that are melted and cast. They typically provide access, protection, or housing for components incorporated into utility owned drinking water, storm water, wastewater, and surface infrastructure. They are typically made of grey or ductile iron, or steel. Examples of municipal castings are:

- Access Hatches;
- Ballast Screen;
- Benches (Iron or Steel);
- Bollards;
- Cast Bases;
- Cast Iron Hinged Hatches, Square and Rectangular;
- Cast Iron Riser Rings;
- Catch Basin Inlet;
- Cleanout/Monument Boxes;
- Construction Covers and Frames;
- Curb and Corner Guards;
- Curb Openings;
- Detectable Warning Plates;
- Downspout Shoes (Boot, Inlet);
- Drainage Grates, Frames and Curb Inlets;
- Inlets;
- Junction Boxes;
- Lampposts;
- Manhole Covers, Rings and Frames, Risers;

Meter Boxes;
Service Boxes;
Steel Hinged Hatches, Square and Rectangular;
Steel Riser Rings;
Trash receptacles;
Tree Grates;
Tree Guards;
Trench Grates; and
Valve Boxes, Covers and Risers.

20) What is ‘structural steel’?

Structural steel is rolled flanged shapes, having at least one dimension of their cross-section three inches or greater, which are used in the construction of bridges, buildings, ships, railroad rolling stock, and for numerous other constructional purposes. Such shapes are designated as wide-flange shapes, standard I-beams, channels, angles, tees and zebs. Other shapes include H-piles, sheet piling, tie plates, cross ties, and those for other special purposes.

21) What is a ‘construction material’ for purposes of the AIS requirement?

Construction materials are those articles, materials, or supplies made primarily of iron and steel, that are permanently incorporated into the project, not including mechanical and/or electrical components, equipment and systems. Some of these products may overlap with what is also considered “structural steel”. This includes, but is not limited to, the following products: wire rod, bar, angles, concrete reinforcing bar, wire, wire cloth, wire rope and cables, tubing, framing, joists, trusses, fasteners (i.e., nuts and bolts), welding rods, decking, grating, railings, stairs, access ramps, fire escapes, ladders, wall panels, dome structures, roofing, ductwork, surface drains, cable hanging systems, manhole steps, fencing and fence tubing, guardrails, doors, and stationary screens.

22) What is not considered a ‘construction material’ for purposes of the AIS requirement?

Mechanical and electrical components, equipment and systems are not considered construction materials. Mechanical equipment is typically that which has motorized parts and/or is powered by a motor. Electrical equipment is typically any machine powered by electricity and includes components that are part of the electrical distribution system.

The following examples (including their appurtenances necessary for their intended use and operation) are NOT considered construction materials: pumps, motors, gear reducers, drives (including variable frequency drives (VFDs)), electric/pneumatic/manual accessories used to operate valves (such as electric valve actuators), mixers, gates, motorized screens (such as traveling screens), blowers/aeration equipment, compressors, meters, sensors, controls and switches, supervisory control and

data acquisition (SCADA), membrane bioreactor systems, membrane filtration systems, filters, clarifiers and clarifier mechanisms, rakes, grinders, disinfection systems, presses (including belt presses), conveyors, cranes, HVAC (excluding ductwork), water heaters, heat exchangers, generators, cabinetry and housings (such as electrical boxes/enclosures), lighting fixtures, electrical conduit, emergency life systems, metal office furniture, shelving, laboratory equipment, analytical instrumentation, and dewatering equipment.

23) If the iron or steel is produced in the US, may other steps in the manufacturing process take place outside of the US, such as assembly?

No. Production in the US of the iron or steel used in a listed product requires that all manufacturing processes must take place in the United States, except metallurgical processes involving refinement of steel additives.

24) What processes must occur in the US to be compliant with the AIS requirement for reinforced precast concrete?

While reinforced precast concrete may not be at least 50% iron or steel, in this particular case, the reinforcing bar and wire must be produced in the US and meet the same standards as for any other iron or steel product. Additionally, the casting of the concrete product must take place in the US. The cement and other raw materials used in concrete production are not required to be of domestic origin.

If the reinforced concrete is cast at the construction site, the reinforcing bar and wire are considered to be a construction material and must be produced in the US.

Compliance

25) How should an assistance recipient document compliance with the AIS requirement?

In order to ensure compliance with the AIS requirement, specific AIS contract language must be included in each contract, starting with the assistance agreement, all the way down to the purchase agreements. Sample language for assistance agreements and contracts can be found in Appendix 3 and 4.

EPA recommends the use of a step certification process, similar to one used by the Federal Highway Administration. The step certification process is a method to ensure that producers adhere to the AIS requirement and assistance recipients can verify that products comply with the AIS requirement. The process also establishes accountability and better enables States to take enforcement actions against violators.

Step certification creates a paper trail which documents the location of the manufacturing process involved with the production of steel and iron materials. A step certification is a process under which each handler (supplier, fabricator, manufacturer,

processor, etc) of the iron and steel products certifies that their step in the process was domestically performed. Each time a step in the manufacturing process takes place, the manufacturer delivers its work along with a certification of its origin. A certification can be quite simple. Typically, it includes the name of the manufacturer, the location of the manufacturing facility where the product or process took place (not its headquarters), a description of the product or item being delivered, and a signature by a manufacturer's responsible party. Attached, as Appendix 5, are sample certifications. These certifications should be collected and maintained by assistance recipients.

Alternatively, the final manufacturer that delivers the iron or steel product to the worksite, vendor, or contractor, may provide a certification asserting that all manufacturing processes occurred in the US. While this type of certification may be acceptable, it may not provide the same degree of assurance. Additional documentation may be needed if the certification is lacking important information. Step certification is the best practice.

26) How should a State ensure assistance recipients are complying with the AIS requirement?

In order to ensure compliance with the AIS requirement, States SRF programs must include specific AIS contract language in the assistance agreement. Sample language for assistance agreements can be found in Appendix 3.

States should also, as a best practice, conduct site visits of projects during construction and review documentation demonstrating proof of compliance which the assistance recipient has gathered.

27) What happens if a State or EPA finds a non-compliant iron and/or steel product permanently incorporated in the project?

If a potentially non-compliant product is identified, the State should notify the assistance recipient of the apparent unauthorized use of the non-domestic component, including a proposed corrective action, and should be given the opportunity to reply. If unauthorized use is confirmed, the State can take one or more of the following actions: request a waiver where appropriate; require the removal of the non-domestic item; or withhold payment for all or part of the project. Only EPA can issue waivers to authorize the use of a non-domestic item. EPA may use remedies available to it under the Clean Water Act, the Safe Drinking Water Act, and 40 CFR part 31 grant regulations, in the event of a violation of a grant term and condition.

It is recommended that the State work collaboratively with EPA to determine the appropriate corrective action, especially in cases where the State is the one who identifies the item in noncompliance or there is a disagreement with the assistance recipient.

If fraud, waste, abuse, or any violation of the law is suspected, the Office of Inspector General (OIG) should be contacted immediately. The OIG can be reached at 1-

888-546-8740 or OIG_Hotline@epa.gov. More information can be found at this website: <http://www.epa.gov/oig/hotline.htm>.

28) How do international trade agreements affect the implementation of the AIS requirements?

The AIS provision applies in a manner consistent with United States obligations under international agreements. Typically, these obligations only apply to direct procurement by the entities that are signatories to such agreements. In general, SRF assistance recipients are not signatories to such agreements, so these agreements have no impact on this AIS provision. In the few instances where such an agreement applies to a municipality, that municipality is under the obligation to determine its applicability and requirements and document the actions taken to comply for the State.

Waiver Process

The statute permits EPA to issue waivers for a case or category of cases where EPA finds (1) that applying these requirements would be inconsistent with the public interest; (2) iron and steel products are not produced in the US in sufficient and reasonably available quantities and of a satisfactory quality; or (3) inclusion of iron and steel products produced in the US will increase the cost of the overall project by more than 25 percent.

In order to implement the AIS requirements, EPA has developed an approach to allow for effective and efficient implementation of the waiver process to allow projects to proceed in a timely manner. The framework described below will allow States, on behalf of the assistance recipients, to apply for waivers of the AIS requirement directly to EPA Headquarters. Only waiver requests received from states will be considered. Pursuant to the Act, EPA has the responsibility to make findings as to the issuance of waivers to the AIS requirements.

Definitions

The following terms are critical to the interpretation and implementation of the AIS requirements and apply to the process described in this memorandum:

Reasonably Available Quantity: The quantity of iron or steel products is available or will be available at the time needed and place needed, and in the proper form or specification as specified in the project plans and design.

Satisfactory Quality: The quality of iron or steel products, as specified in the project plans and designs.

Assistance Recipient: A borrower or grantee that receives funding from a State CWSRF or DWSRF program.

Step-By-Step Waiver Process

Application by Assistance Recipient

Each local entity that receives SRF water infrastructure financial assistance is required by section 436 of the Act to use American made iron and steel products in the construction of its project. However, the recipient may request a waiver. Until a waiver is granted by EPA, the AIS requirement stands, except as noted above with respect to municipalities covered by international agreements.

The waiver process begins with the SRF assistance recipient. In order to fulfill the AIS requirement, the assistance recipient must in good faith design the project (where applicable) and solicit bids for construction with American made iron and steel products. It is essential that the assistance recipient include the AIS terms in any request for proposals or solicitations for bids, and in all contracts (see Appendix 3 for sample construction contract language). The assistance recipient may receive a waiver at any point before, during, or after the bid process, if one or more of three conditions is met:

1. Applying the American Iron and Steel requirements of the Act would be inconsistent with the public interest;
2. Iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or
3. Inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

Proper and sufficient documentation must be provided by the assistance recipient. A checklist detailing the types of information required for a waiver to be processed is attached as Appendix 1.

Additionally, it is strongly encouraged that assistance recipients hold pre-bid conferences with potential bidders. A pre-bid conference can help to identify iron and steel products needed to complete the project as described in the plans and specifications that may not be available from domestic sources. It may also identify the need to seek a waiver prior to bid, and can help inform the recipient on compliance options.

In order to apply for a project waiver, the assistance recipient should email the request in the form of a Word document (.doc) to the State SRF program. It is strongly recommended that the State designate a single person for all AIS communications. The State SRF designee will review the application for the waiver and determine whether the necessary information has been included. Once the waiver application is complete, the State designee will forward the application to either of two email addresses. For CWSRF waiver requests, please send the application to: cwsrfwaiver@epa.gov. For DWSRF waiver requests, please send the application to: dwsrfwaiver@epa.gov.

Evaluation by EPA

After receiving an application for waiver of the AIS requirements, EPA Headquarters will publish the request on its website for 15 days and receive informal comment. EPA Headquarters will then use the checklist in Appendix 2 to determine whether the application properly and adequately documents and justifies the statutory basis cited for the waiver – that it is quantitatively and qualitatively sufficient – and to determine whether or not to grant the waiver.

In the event that EPA finds that adequate documentation and justification has been submitted, the Administrator may grant a waiver to the assistance recipient. EPA will notify the State designee that a waiver request has been approved or denied as soon as such a decision has been made. Granting such a waiver is a three-step process:

1. Posting – After receiving an application for a waiver, EPA is required to publish the application and all material submitted with the application on EPA's website for 15 days. During that period, the public will have the opportunity to review the request and provide informal comment to EPA. The website can be found at: http://water.epa.gov/grants_funding/aisrequirement.cfm
2. Evaluation – After receiving an application for waiver of the AIS requirements, EPA Headquarters will use the checklist in Appendix 2 to determine whether the application properly and adequately documents and justifies the statutory basis cited for the waiver – that it is quantitatively and qualitatively sufficient – and to determine whether or not to grant the waiver.
3. Signature of waiver approval by the Administrator or another agency official with delegated authority – As soon as the waiver is signed and dated, EPA will notify the State SRF program, and post the signed waiver on our website. The assistance recipient should keep a copy of the signed waiver in its project files.

Public Interest Waivers

EPA has the authority to issue public interest waivers. Evaluation of a public interest waiver request may be more complicated than that of other waiver requests so they may take more time than other waiver requests for a decision to be made. An example of a public interest waiver that might be issued could be for a community that has standardized on a particular type or manufacturer of a valve because of its performance to meet their specifications. Switching to an alternative valve may require staff to be trained on the new equipment and additional spare parts would need to be purchased and stocked, existing valves may need to be unnecessarily replaced, and portions of the system may need to be redesigned. Therefore, requiring the community to install an alternative valve would be inconsistent with public interest.

EPA also has the authority to issue a public interest waiver that covers categories of products that might apply to all projects.

EPA reserves the right to issue national waivers that may apply to particular classes of assistance recipients, particular classes of projects, or particular categories of iron or steel products. EPA may develop national or (US geographic) regional categorical waivers through the identification of similar circumstances in the detailed justifications presented to EPA in a waiver request or requests. EPA may issue a national waiver based on policy decisions regarding the public's interest or a determination that a particular item is not produced domestically in reasonably available quantities or of a sufficient quality. In such cases, EPA may determine it is necessary to issue a national waiver.

If you have any questions concerning the contents of this memorandum, you may contact us, or have your staff contact Jordan Dorfman, Attorney-Advisor, State Revolving Fund Branch, Municipal Support Division, at dorfman.jordan@epa.gov or (202) 564-0614 or Kiri Anderer, Environmental Engineer, Infrastructure Branch, Drinking Water Protection Division, at anderer.kirsten@epa.gov or (202) 564-3134.

Attachments

Appendix 1: Information Checklist for Waiver Request

The purpose of this checklist is to help ensure that all appropriate and necessary information is submitted to EPA. EPA recommends that States review this checklist carefully and provide all appropriate information to EPA. This checklist is for informational purposes only and does not need to be included as part of a waiver application.

Items	✓	Notes
General • Waiver request includes the following information: — Description of the foreign and domestic construction materials — Unit of measure — Quantity — Price — Time of delivery or availability — Location of the construction project — Name and address of the proposed supplier — A detailed justification for the use of foreign construction materials • Waiver request was submitted according to the instructions in the memorandum • Assistance recipient made a good faith effort to solicit bids for domestic iron and steel products, as demonstrated by language in requests for proposals, contracts, and communications with the prime contractor		
Cost Waiver Requests • Waiver request includes the following information: — Comparison of overall cost of project with domestic iron and steel products to overall cost of project with foreign iron and steel products — Relevant excerpts from the bid documents used by the contractors to complete the comparison — Supporting documentation indicating that the contractor made a reasonable survey of the market, such as a description of the process for identifying suppliers and a list of contacted suppliers		
Availability Waiver Requests • Waiver request includes the following supporting documentation necessary to demonstrate the availability, quantity, and/or quality of the materials for which the waiver is requested: — Supplier information or pricing information from a reasonable number of domestic suppliers indicating availability/delivery date for construction materials — Documentation of the assistance recipient's efforts to find available domestic sources, such as a description of the process for identifying suppliers and a list of contacted suppliers. — Project schedule — Relevant excerpts from project plans, specifications, and permits indicating the required quantity and quality of construction materials • Waiver request includes a statement from the prime contractor and/or supplier confirming the non-availability of the domestic construction materials for which the waiver is sought • Has the State received other waiver requests for the materials described in this waiver request, for comparable projects?		

Appendix 2: HQ Review Checklist for Waiver Request

Instructions: To be completed by EPA. Review all waiver requests using the questions in the checklist, and mark the appropriate box as Yes, No or N/A. Marks that fall inside the shaded boxes may be grounds for denying the waiver. If none of your review markings fall into a shaded box, the waiver is eligible for approval if it indicates that one or more of the following conditions applies to the domestic product for which the waiver is sought:

1. The iron and/or steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality.
2. The inclusion of iron and/or steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

Review Items	Yes	No	N/A	Comments
Cost Waiver Requests				
• Does the waiver request include the following information?				
— Comparison of overall cost of project with domestic iron and steel products to overall cost of project with foreign iron and steel products				
— Relevant excerpts from the bid documents used by the contractors to complete the comparison				
— A sufficient number of bid documents or pricing information from domestic sources to constitute a reasonable survey of the market				
• Does the Total Domestic Project exceed the Total Foreign Project Cost by more than 25%?				
Availability Waiver Requests				
• Does the waiver request include supporting documentation sufficient to show the availability, quantity, and/or quality of the iron and/or steel product for which the waiver is requested?				
— Supplier information or other documentation indicating availability/delivery date for materials				
— Project schedule				
— Relevant excerpts from project plans, specifications, and permits indicating the required quantity and quality of materials				
• Does supporting documentation provide sufficient evidence that the contractors made a reasonable effort to locate domestic suppliers of materials, such as a description of the process for identifying suppliers and a list of contacted suppliers?				
• Based on the materials delivery/availability date indicated in the supporting documentation, will the materials be unavailable when they are needed according to the project schedule? (By item, list schedule date and domestic delivery quote date or other relevant information)				
• Is EPA aware of any other evidence indicating the non-availability of the materials for which the waiver is requested?				
Examples include:				
— Multiple waiver requests for the materials described in this waiver request, for comparable projects in the same State				
— Multiple waiver requests for the materials described in this waiver request, for comparable projects in other States				
— Correspondence with construction trade associations indicating the non-availability of the materials				
• Are the available domestic materials indicated in the bid documents of inadequate quality compared those required by the project plans, specifications, and/or permits?				

Appendix 3: Example Loan Agreement Language

ALL ASSISTANCE AGREEMENT MUST HAVE A CLAUSE REQUIRING COMPLIANCE WITH THE AIS REQUIREMENT. THIS IS AN EXAMPLE OF WHAT COULD BE INCLUDED IN SRF ASSISTANCE AGREEMENTS. EPA MAKES NO CLAIMS REGARDING THE LEGALITY OF THIS CLAUSE WITH RESPECT TO STATE LAW:

Comply with all federal requirements applicable to the Loan (including those imposed by the 2014 Appropriations Act and related SRF Policy Guidelines) which the Participant understands includes, among other, requirements that all of the iron and steel products used in the Project are to be produced in the United States (“American Iron and Steel Requirement”) unless (i) the Participant has requested and obtained a waiver from the Agency pertaining to the Project or (ii) the Finance Authority has otherwise advised the Participant in writing that the American Iron and Steel Requirement is not applicable to the Project.

Comply with all record keeping and reporting requirements under the Clean Water Act/Safe Drinking Water Act, including any reports required by a Federal agency or the Finance Authority such as performance indicators of program deliverables, information on costs and project progress. The Participant understands that (i) each contract and subcontract related to the Project is subject to audit by appropriate federal and state entities and (ii) failure to comply with the Clean Water Act/Safe Drinking Water Act and this Agreement may be a default hereunder that results in a repayment of the Loan in advance of the maturity of the Bonds and/or other remedial actions.

Appendix 4: Sample Construction Contract Language

ALL CONTRACTS MUST HAVE A CLAUSE REQUIRING COMPLIANCE WITH THE AIS REQUIREMENT. THIS IS AN EXAMPLE OF WHAT COULD BE INCLUDED IN ALL CONTRACTS IN PROJECTS THAT USE SRF FUNDS. EPA MAKES NO CLAIMS REGARDING THE LEGALITY OF THIS CLAUSE WITH RESPECT TO STATE OR LOCAL LAW:

The Contractor acknowledges to and for the benefit of the City of _____ (“Purchaser”) and the _____ (the “State”) that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund and/or Drinking Water State Revolving Fund that have statutory requirements commonly known as “American Iron and Steel;” that requires all of the iron and steel products used in the project to be produced in the United States (“American Iron and Steel Requirement”) including iron and steel products provided by the Contractor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the State. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney’s fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser). While the Contractor has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State.

Appendix 5: Sample Certifications

The following information is provided as a sample letter of **step** certification for AIS compliance. Documentation must be provided on company letterhead.

Date

Company Name

Company Address

City, State Zip

Subject: American Iron and Steel Step Certification for Project (XXXXXXXXXX)

I, (company representative), certify that the (melting, bending, coating, galvanizing, cutting, etc.) process for (manufacturing or fabricating) the following products and/or materials shipped or provided for the subject project is in full compliance with the American Iron and Steel requirement as mandated in EPA's State Revolving Fund Programs.

Item, Products and/or Materials:

1. XXXX
2. XXXX
3. XXXX

Such process took place at the following location:

If any of the above compliance statements change while providing material to this project we will immediately notify the prime contractor and the engineer.

Signed by company representative

The following information is provided as a sample letter of certification for AIS compliance. Documentation must be provided on company letterhead.

Date

Company Name

Company Address

City, State Zip

Subject: American Iron and Steel Certification for Project (XXXXXXXXXX)

I, (company representative), certify that the following products and/or materials shipped/provided to the subject project are in full compliance with the American Iron and Steel requirement as mandated in EPA's State Revolving Fund Programs.

Item, Products and/or Materials:

1. XXXX
2. XXXX
3. XXXX

Such process took place at the following location:

If any of the above compliance statements change while providing material to this project we will immediately notify the prime contractor and the engineer.

Signed by company representative

**American Iron & Steel (AIS) Requirement of the Consolidated Appropriations Act of 2014
(Public Law 113-76)**

Q&A Part 2

PRODUCT QUESTIONS

1. Q: Do all fasteners qualify for de minimis exemption?

A: No. There is no broad exemption for fasteners from the American Iron and Steel (AIS) requirements. Significant fasteners used in SRF projects are not subject to the de minimis waiver for projects and must comply with the AIS requirements. Significant fasteners include fasteners produced to industry standards (e.g., ASTM standards) and/or project specifications, special ordered or those of high value. When bulk purchase of unknown-origin fasteners that are of incidental use and small value are used on a project, they may fall under the national de minimis waiver for projects. The list of potential items could be varied, such as big-box/hardware-store-variety screws, nails, and staples. The key characteristics of the items that may qualify for the de minimis waiver would be items that are incidental to the project purpose (such as drywall screws) and not significant in value or purpose (such as common nails or brads). See the following: http://water.epa.gov/grants_funding/upload/Deminimis-Waiver-04-15-14.pdf.

EPA also clarifies that minor components of two listed products – valves and hydrants -- may not need to meet the AIS requirements if the minor components comprise a very small quantity of minor, low-cost fasteners that are of unknown origin. See EPA's questions and answers on the subject at the following: http://water.epa.gov/grants_funding/upload/AIS-QandA-Part-1-Valves-and-Hydrants-final.pdf.

2. Q: Does PCCP pipe have to be domestically produced?

A: Yes. Pre-stressed concrete cylinder pipe (PCCP) or other similar concrete cylinder pipes would be comparable to pre-cast concrete which is specifically listed in the Consolidated Appropriations Act of 2014 as a product subject to the AIS requirement.

3. Q: If the iron or steel is made from recycled metals will the vendor/supplier have to provide a certification document certifying that the recycled metals are domestically produced?

A: No. Recycled source materials used in the production of iron and steel products do not have to come from the U.S. Iron or steel scrap, for instance, are considered raw materials that may come from anywhere. While certification is not required for the raw material, EPA does recommend that additional final processing of iron and steel be certified to have occurred in the U.S.

4. Q: Do tanks used for filtration systems, if delivered to the construction site separately and then filled with filtration media onsite, have to be domestically produced?

A: No. Tanks that are specifically designed to be filters, or as parts of a filtration system, do not have to be domestically produced because these parts are no longer simply tanks, even if the filter media has not been installed and will be installed at the project site, as is customary to do for shipping purposes. These parts have only one purpose which is to be housing for filters and cannot be used in another fashion.

5. Q: Can a recipient use non-domestic flanged pipe?

A: No. While the Consolidated Appropriations Act of 2014 does not specifically mention flanged pipe, since it does mention both pipe and flanges, both products would need to be domestically produced. Therefore, flanged pipe would also need to be domestically produced.

6. Q: Can a recipient use non-domestic couplings, expansion joints, and other similar pipe connectors?

A: No. These products would be considered specialty fittings, due to their additional functionality, but still categorized under the larger “fitting” categorization. Fittings are defined as a material that joins pipes together or connects to a pipe (AWWA, The Drinking Water Dictionary, 2000). Therefore, these products must comply with the AIS requirements and be produced domestically.

7. Q: Can a recipient use non-domestic service saddles and tapping sleeves?

A: No. These products are necessary for pipe repair, to tap a water main, or to install a service or house connection. Therefore, they are included under the larger “pipe restraint” category which is a specifically identified product subject to the domestic preference in the Consolidated Appropriations Act of 2014.

8. Q: The AIS guidance does not appear to cover reused items (i.e., existing pipe fittings, used storage tanks, reusing existing valves). How should reused items be addressed?

A: The AIS guidance does not address reuse of items. Reuse of items that would otherwise be covered by AIS is acceptable provided that the item(s) was originally purchased prior to January 17, 2014, the reused item(s) is not substantially altered from original form/function, and any restoration work that may be required does not include the replacement or addition of foreign iron or steel replacement parts. EPA recommends keeping a log of these reused items by including them on the assistance recipient’s de minimis list, and stating therein that these items are reused products. The donation of new items (such as a manufacturer waiving cost for certain delivered items because of concerns regarding the origin of a new product) is not, however, considered reuse.

9. Q: What does “time needed” mean in the AIS guidance, in reference to the definition of “Reasonably Available Quantity”?

A: For considering whether a product would meet reasonably available quantity, “time needed” is based on the construction schedule. If the item is delayed and there is substantial impact on the overall construction schedule, this would not be according to the “time needed.”

10. Q: If a product is not specifically included on the list of AIS covered products, must it comply with AIS?

A: Possibly. The AIS requirements include a list of specifically covered products, one of which is construction materials, a broad category of potential products. For construction materials, EPA’s AIS guidance includes a set of example items that it considers construction materials composed primarily of iron and steel and covered by the Act. This example list in the guidance is not an all-inclusive list of potential construction materials. However, the guidance also includes a list of items that EPA specifically does not consider construction materials, generally those of electrical or complex-mechanical nature. If a product is similar to the ones in the non-construction material list (and it is also not specifically listed by the Act), it is not a construction material. For all other items specifically included in the Act, coverage is generally self-evident.

11. Q: If a listed iron and steel product is used as a part for an assembled product that is non-domestic, do the AIS requirements apply?

A: AIS requirements only apply to the final product as delivered to the work site and incorporated into the project. Other assemblies, such as a pumping assembly or a reverse osmosis package plant, are distinct products not listed and do not need to be made in the U.S. or composed of all U.S. parts. Therefore, for the case of a non-covered product used in a larger non-domestic assembly, the components, even if specifically listed in the Consolidated Appropriations Act, do not have to be domestically produced.

12. Q: Is cast iron excluded from the AIS requirements?

A: No. Cast iron products that fall under the definition of iron and steel products must comply with the AIS requirements.

13. Q: The guidance states that “construction materials” do not include mechanical equipment, but then identifies ductwork as a construction material. Please clarify.

A: Ductwork is not mechanical equipment, therefore it is considered a “construction material” and must comply with the AIS requirements.

14. Q: Do “meters” mentioned in EPA’s guidance as non-construction materials include both flow meters and water meters?

A: Yes. “Meters” includes any type of meter, including: flow meters, wholesale meters, and water meters/service connections.

15. Q: Must coiled steel be domestic?

A: Yes. Coiled steel is an intermediate product used in the production of steel pipe and must come from a U.S. source or subject to a waiver in order to comply with the AIS requirements.

16. Q: Are pig iron, direct reduced iron (DRI), and ingot considered raw materials?

A: No. These are considered intermediate products used in the production of iron or steel and must come from a U.S. source or subject to a waiver in order to comply with the AIS requirements.

17. Q: Can assistance recipients rely on a marking that reads, “Made in the USA,” as evidence that all processes took place in the U.S.?

A: No. This designation is not consistent with our requirements that all manufacturing processes of iron and steel products must take place in the U.S.

18. Q: When determining what constitutes a product made “primarily” of iron or steel, who makes this determination?

A: The manufacturer will show if its product qualifies as primarily made of iron or steel. The recipient should expect the manufacturer to provide documentation/ certification that its product is AIS compliant.

19. Q: Do aerators need to be produced domestically in order to comply with AIS?

A: No. Aerators, similar to pumps, are mechanical equipment that do not need to meet the AIS requirements. “Blowers/aeration equipment, compressors” are listed in EPA’s guidance as non-construction materials.

20. Q: Are Sluice and Slide Gates considered valves?

A: No. Valves are products that are generally encased / enclosed with a body, bonnet, and stem. Examples include enclosed butterfly, ball, globe, piston, check, wedge, and gate valves. Furthermore, “gates” (meaning sluice, slide or weir gates) are listed in EPA’s guidance as non-construction materials.

AIS PROCESS QUESTIONS

21. Q: Will notices of waiver applications be published in the federal register?

A: No. Applications for waivers will be published on EPA’s website (http://water.epa.gov/grants_funding/aisrequirement.cfm). EPA will provide 15 days for open public comment, as noted on the website.

22. Q: Will states be collecting the step certification paper trail, as presented in the AIS guidance?

A. No. Assistance recipients must maintain documentation of compliance with AIS. EPA recommends use of the step certification process. This process is a best practice and traces all manufacturing of iron and steel products to the U.S. If the process is used, the state does not have to collect the documentation. The documents must be kept by the assistance recipient and reviewed by the state during project reviews.

23. Q: Why is it considered a best practice for states to conduct site visits, when it is the assistance recipient's responsibility to meet the AIS requirements?

A: It is both the assistance recipient's and the state's responsibility to ensure compliance with the AIS requirements. The state is the recipient of a federal grant and must comply with all grant conditions, including a condition requiring that the AIS requirements be adhered to. Therefore, it is recommended that states conduct site visits of projects during construction and review documentation demonstrating the assistance recipient's proof of compliance.

24. Q: Please further define the state's role in the waiver process.

A: The state's role in the waiver process is to review any waiver requests submitted to the state in order to ensure that all necessary information has been provided by the assistance recipient prior to forwarding the request to EPA. If a state finds the request lacking, the state should work with the assistance recipient to help obtain complete information.

25. Q: How much time does EPA have to evaluate the waiver during the evaluation step?

A: At a minimum, EPA is required to provide 15 days for open public comment. There is no specific deadline or time limit for EPA to review waiver requests. Each waiver request will come with its own specific details and circumstances and may require a different amount of time for review and analysis. For example, public interest waivers in general may take longer to review than availability waivers which are typically more straightforward. However, EPA understands that construction may be delayed while waiting for a waiver and will make every effort to review and issue decisions on waiver requests in a timely manner.

PROJECT QUESTIONS

26. Q: What if a project is funded by another funding entity (i.e., United States Department of Agriculture – Rural Development) where AIS is not required and begins construction after January 17, 2014 but then applies to the SRF to refinance the project? Are they ineligible?

A: The project is not ineligible. AIS requirements will apply to any construction that occurs after the assistance agreement is signed, through the end of construction. If construction is complete, there is no retroactive application of the AIS requirements.

27. Q: If the assistance recipient can demonstrate through market research that the AIS requirement will exceed the 25 percent cost threshold, is the entire project exempt from the AIS requirement?

A: If the waiver application shows that the inclusion of American iron and steel products causes the entire cost of the project to increase by more the 25 percent, a waiver may be granted for the entirety of the project.

28. Q: Can the recipient use non-SRF funds to pay for the non-compliant item.

A: No. It is not an acceptable to use non-SRF funds to pay for a non-compliant item. The Consolidated Appropriations Act of 2014 requires that all iron and steel products, no matter the source of funding, must be made in the U.S. if SRF funds are used in the project.

29. Q: What constitutes “satisfactory quality” as defined in the AIS guidance, in reference to the availability waiver process.

A: “Satisfactory quality” means the product meets the project design specifications. A waiver may be granted if a recipient determines that the project plans and design would be compromised because there are no American made products available that meet the project design specifications.

30. Q: The guidance states that the AIS requirement applies to any project “funded in whole or in part” by an SRF. Where is this in the Act?

A: The Act states that, “None of the funds made available by a ... [State SRF program] ... shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States.” This sentence clearly states that no SRF program may use its funds for a project unless all of the iron and steel products used in the project are made in the U.S. This is true even if only \$1 of SRF funding is used in the project.

31. Q: There is always an expectation on the part of an assistance recipient that the construction phase of a planning and/or design only loan will be funded through the SRF. If the original planning and/or design only loan was executed prior to a January 17, 2014, does this mean the entire project will be exempt from the AIS requirement?

A: If the original loan includes construction, and was executed prior to January 17, 2014, then the AIS provision does not apply to the project. If the original loan was only for planning and/or design, then a written commitment or documented “expectation” is needed to show exemption from the

requirements. Appearance on a priority list in an Intended Use Plan along with written reasonable assurance from the state that the recipient will receive SRF funding for project construction could provide sufficient evidence of “expectation of funding”.

32. Q: What if there has been a change order or redesign requiring new plans and specifications to be approved and they were approved after January 17, 2014: does the project now have to comply with AIS?

A: In most cases, no. Change orders are typically small enough changes that the original plan and specification date will still hold true. For example, if a pipe alignment has to be changed for a block or two due to unforeseen conditions, but new plans and specifications had to be submitted for this section of the project, then that could be considered a minor change. However, if there has been a major redesign, perhaps the whole project had to be redesigned starting from scratch, then the new plans and specification approval date would apply.

33. Q: What if the bids on a project with plans and specifications approved before January 17, 2014 but the loan is signed after January 17, 2014 come in low, and there is significant funding remaining in the loan agreement, so the community designs a second project with the remaining funds: does that project have to comply with the AIS requirements?

A: If the second project is closely related in purpose, place and time to the first project, then the second project would be exempt from the AIS requirements. It is the assistance recipient’s responsibility (with state oversight) to show that a project is closely related, or not, in purpose, place and time.

34. Q: What if the assistance agreement was signed after January 17, 2014, state approval of plans for the first phase of the project was in place prior to January 17, 2014, but state approval of the plans for the second phase of the project was received after January 17, 2014?

A: In such a case, the AIS provision would not apply to the first phase of the project. If the second phase of the project is considered the same project as the first phase, due to its close relation in purpose, place and time, the entire project may be exempt. It is the assistance recipient’s responsibility (with state oversight) to show that phases of a project is closely related, or not, in purpose, place and time.

35. Q: Do products purchased through procurement-only contracts have to be comply with AIS?

A: Yes. For projects funded by SRF, the products procured under any form of contract must comply with AIS. A procurement-only contract generally involves the bulk purchase of common items (such as pipe, concrete, and/or pumps) of independent timing from a set of planned projects. If products which are purchased through a procurement-only contract are being installed under another contract, the procurement-only contract would probably not be considered a separate project in purpose, place and time; and therefore, would have to comply with the AIS requirements.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF WATER

DECISION MEMORANDUM

SUBJECT: De Minimis Waiver of Section 436 of P.L. 113-76, Consolidated Appropriations Act (CAA), 2014

FROM: Nancy K. Stoner
Acting Assistant Administrator

The EPA is hereby granting a nationwide waiver pursuant to the “American Iron and Steel (AIS)” requirements of P.L. 113-76, Consolidated Appropriations Act, 2014 (Act), section 436 under the authority of Section 436(b)(1) (public interest waiver) for de minimis incidental components of eligible water infrastructure projects. This action permits the use of products when they occur in de minimis incidental components of such projects funded by the Act that may otherwise be prohibited under section 436(a). Funds used for such de minimis incidental components cumulatively may comprise no more than a total of 5 percent of the total cost of the materials used in and incorporated into a project; the cost of an individual item may not exceed 1 percent of the total cost of the materials used in and incorporated into a project.

P.L. 113-76, Consolidated Appropriations Act, 2014 (Act), includes an “American Iron and Steel” (AIS) requirement in section 436 that requires Clean Water State Revolving Loan Fund (CWSRF) and Drinking Water State Revolving Loan Fund (DWSRF) assistance recipients to use specific domestic iron and steel products that are produced in the United States if the project is funded through an assistance agreement executed beginning January 17, 2014 (enactment of the Act), through the end of Fiscal Year 2014, unless the agency determines it necessary to waive this requirement based on findings set forth in Section 436(b). The Act states, “[the requirements] shall not apply in any case or category of cases in which the Administrator of the Environmental Protection Agency...finds that— (1) applying subsection (a) would be inconsistent with the public interest” 436(b)(1).

In implementing section 436 of the Act, the EPA must ensure that the section's requirements are applied consistent with congressional intent in adopting this section and in the broader context of the purposes, objectives, and other provisions applicable to projects funded under the SRF. Water infrastructure projects typically contain a relatively small number of high-cost components incorporated into the project. In bid solicitations for a project, these high-cost components are generally described in detail via project specific technical specifications. For these major components, utility owners and their contractors are generally familiar with the conditions of availability, the potential alternatives for each detailed specification, the approximate cost, and the country of manufacture of the available components.

Every water infrastructure project also involves the use of thousands of miscellaneous, generally low-cost components that are essential for, but incidental to, the construction and are incorporated into the physical structure of the project. For many of these incidental components, the country of manufacture and the availability of alternatives is not always readily or reasonably identifiable prior to procurement in the normal course of business; for other incidental components, the country of manufacture may be known but the miscellaneous character in conjunction with the low cost, individually and (in total) as typically procured in bulk, mark them as properly incidental. Examples of incidental components could include small washers, screws, fasteners (i.e., nuts and bolts), miscellaneous wire, corner bead, ancillary tube, etc. Examples of items that are clearly not incidental include significant process fittings (i.e., tees, elbows, flanges, and brackets), distribution system fittings and valves, force main valves, pipes for sewer collection and/or water distribution, treatment and storage tanks, large structural support structures, etc.

The EPA undertook multiple inquiries to identify the approximate scope of de minimis incidental components within water infrastructure projects during the implementation of the American Reinvestment and Recovery Act (ARRA) and its requirements (Buy American provisions, specifically). The inquiries and research conducted in 2009 applies suitably for the case today. In 2009, the EPA consulted informally with many major associations representing equipment manufacturers and suppliers, construction contractors, consulting engineers, and water and wastewater utilities, and performed targeted interviews with several well-established water infrastructure contractors and firms who work in a variety of project sizes, and regional and demographic settings to ask the following questions:

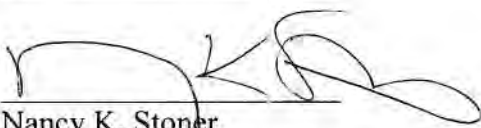
- What percentage of total project costs were consumables or incidental costs?
- What percentage of materials costs were consumables or incidental costs?
- Did these percentages vary by type of project (drinking water vs. wastewater treatment plant vs. pipe)?

The responses were consistent across the variety of settings and project types, and indicated that the percentage of total costs for drinking water or wastewater infrastructure projects represented by these incidental components is generally not in excess of 5 percent of the total cost of the materials used in and incorporated into a project. In drafting this waiver, the EPA has considered the de minimis proportion of project costs generally represented by each individual type of these incidental components within the many types of such components comprising those percentages, the fact that these types of incidental components are obtained by contractors in many different ways from many different sources, and the disproportionate cost and delay that would be imposed on projects if the EPA did not issue this waiver.

Assistance recipients who wish to use this waiver should in consultation with their contractors determine the items to be covered by this waiver and must retain relevant documentation (i.e., invoices) as to those items in their project files.

If you have any questions concerning the contents of this memorandum, please contact Timothy Connor, Chemical Engineer, Municipal Support Division, at connor.timothy@epa.gov or (202) 566-1059 or Kirsten Anderer, Environmental Engineer, Drinking Water Protection Division, at anderer.kirsten@epa.gov or (202) 564-3134.

Issued on: APR 15 2014

Approved by: 
Nancy K. Stoner
Acting Assistant Administrator

State of Ohio

WATER POLLUTION CONTROL LOAN FUND/WATER SUPPLY REVOLVING LOAN ACCOUNT

CONTRACT CHANGE ORDER

RECIPIENT _____ CHANGE ORDER NBR _____
WPCLF/WSRLA LOAN NBR _____ CONTRACT _____
OWDA PROJECT NBR _____ DATE _____

Description of Change: _____

RECOMMENDED BY: _____ DATE: _____
(Engineer)

APPROVED BY: _____ DATE: _____
(Recipient)

ACCEPTED BY: _____ DATE: _____
(Contractor)

(Contractor Company Name)

		OWDA APPROVAL	
Original Contract Amt	_____	The above proposal is hereby accepted and I recommend that it be approved and made a part of the contract covered by OWDA Project Number _____	
Previous Changes (+ / -)	_____		
This Change (+ / -)	_____		
Adjusted Contract Amt	_____		
OHIO EPA ACCEPTANCE		Chief Engineer	
Ohio EPA ACCEPTANCE		Date	
DATE		Executive Director	
		Date	

CHANGE ORDER INSTRUCTIONS:

All Change Orders for this work, regardless of costs and whether Water Pollution Control Loan Fund (WPCLF) or Water Supply Revolving Loan Account (WSRLA) funding will be used to finance the changes, must be submitted to Ohio EPA for review.

Changes Requiring Prior Approval

Any change which substantially modifies the Project Facilities as specified in the Ohio EPA approved Facilities Plan and Final Permit to Install or Final Plan Approval (when applicable) or alters the direct or indirect impact of the Project Facilities upon the environment must be incorporated into a Change Order. One copy of the Change Order prior to execution is to be submitted to Ohio EPA for review and prior approval of the acceptability of the change. "Prior to execution" means before the Change Order is signed by the Owner.

Ohio EPA will review the Change Order and inform the Owner of the technical, environmental and operational acceptability of the change, and give the Owner permission to proceed with the proposed work.

All Other Changes

Change Orders not requiring prior approval as described above must be submitted to Ohio EPA within one (1) month of the time at which they are approved by the Owner. Change Orders for WPCLF projects should be submitted to the Division of Environmental and Financial Assistance (DEFA) while Change Orders for WSRLA projects should be submitted to the Division of Drinking and Ground Water (DDAGW) in central office.

Change Order Approval Process

After the Change Order is executed, one (1) copy of the Change Order, including the supporting documentation, is to be sent to Ohio EPA for final review. The WPCLF/WSRLA Change Order forms must have original signatures.

Communities have the option to submit hard copies of the project Change Orders via mail to Ohio EPA or to send PDF Change Order forms and supporting documentation electronically. With either hard copy or electronic submittals, the WPCLF Change Orders should be submitted to DEFA and WSRLA Change Orders should be submitted to DDAGW - Central Office.

The dedicated e-mail address for the electronic submittal of WPCLF Change Orders is EPAWPCLFCO@epa.ohio.gov.

The dedicated e-mail address for the electronic submittal of WSRLA Change Orders is EPAWSRLACO@epa.ohio.gov.

After the Change Order is accepted and eligible costs determined, Ohio EPA will issue a letter informing the Owner and authorizing OWDA to disburse funds from Project Contingency for the work. The OEPA letter will be sent electronically. OWDA will return a PDF of the WPCLF/WSRLA Change Order form which will be signed by all parties including Ohio EPA and OWDA.

Please notify Ohio EPA if the community prefers a hard copy of change order approval documentation and then Ohio EPA and OWDA will send hard copies of approval documentation through the mail.

Payments for Change Order Work

The Owner is precluded from submitting to the OWDA payment requests for Eligible Project Costs associated with the Change Orders until such time as the Ohio EPA's approval of the Change Orders has been obtained.

CONTRACTOR'S PERSONAL PROPERTY TAX AFFIDAVIT
(O.R.C. § 5719.042)

State of Ohio

County of _____, ss:

_____, being first duly sworn, deposes and says that he is the
(Name)

_____ of _____ with offices located at
(Title) (Contractor)

_____, and as its duly
(Address of Contractor)

authorized representative, states that effective this ____ day of _____, 20____,

(Name of Contractor)

- () is charged with delinquent personal property taxes on the general list of personal property as set forth below:

<u>County</u>	<u>Amount</u> (includes total amount due, plus penalties and interest thereon)

Stark	\$ _____

- () is not charged with delinquent personal property taxes on the general list of personal property in Stark County.

(Affiant)

Sworn to and subscribed before me by the above-named affiant this ____ day of _____, 20__.

(Notary Public)

My commission expires

_____, 20__



STEC-CC
Rev. 3/15/04

Sales and Use Tax Construction Contract Exemption Certificate

Identification of Contract:

Contractee's (Owner's) name: City of Massillon, Ohio

Exact location of job/project: 100 Big Indian Dr. SW, Massillon, OH 44646

Name of job/project as it appears
on contract documentation: 2013 WWTP Improvements Project - Contract No. 2, General Construction

The undersigned hereby certifies that the tangible personal property purchased under this exemption certificate was purchased for incorporation into:

☒	real property under a construction contract with the United States government, its agencies, the State of Ohio, or an Ohio political subdivision;	☒	real property which is owned, or will be accepted for ownership at the time of completion, by the United States government, its agencies, the State of Ohio, or an Ohio political subdivision;
☐	a horticulture structure or livestock structure for a person engaged in the business of horticulture or producing livestock;	☐	a house of public worship or religious education;
☐	a building used exclusively for charitable purposes by a nonprofit organization operated exclusively for charitable purposes as defined in section 5739.02(B)(12) of the Revised Code;	☐	a building under a construction contract with an organization exempt from taxation under section 501(c)(3) of the Internal Revenue Code of 1986 when the building is to be used exclusively for the organization's exempt purposes;
☐	the original construction of a sports facility under section 307.696 of the Revised Code;	☐	a hospital facility entitled to exemption under section 140.08 of the Revised Code;
☐	real property outside this state if such materials and services, when sold to a construction contractor in the state in which the real property is located for incorporation into real property in that state, would be exempt from a tax on sales levied by that state		

The original of this certificate must be signed by the owner/contractee and/or government official and must be retained by the prime contractor. Copies must be maintained by the owner/contractee and all subcontractors. When copies are issued to suppliers when purchasing materials, each copy must be signed by the contractor or subcontractor making the purchase.

Prime Contractor

Name: _____

Signed by: _____

Title: _____

Street address: _____

City, state, ZIP code: _____

Date: _____

Subcontractor

Name: _____

Signed by: _____

Title: _____

Street address: _____

City, state, ZIP code: _____

Date: _____

Owner/Contractee

Name: City of Massillon

Signed by: _____

Title: _____

Street address: 100 Big Indian Dr. SW

City, state, ZIP code: Massillon, OH 44646

Date: _____

Political Subdivision

Name: _____

Signed by: _____

Title: _____

Street address: _____

City, state, ZIP code: _____

Date: _____

SECTION 00442

DECLARATION OF MANUFACTURER SHEET

CONTRACT No. 2 – General Construction

Specific equipment has been used in preparing the Contract Documents and thus establish minimum quality that is acceptable. The BIDDER must prepare his Base Bid based on equipment manufacturers listed below for equipment which meets the requirements of the specification section listed. For Base Bid equipment items that have only one (1) manufacturer listed, that manufacturer's equipment shall be included in the Base Bid. For Base Bid equipment items that have more than one (1) manufacturer listed, the BIDDER is required to indicate by an "X" in the spaces () provided, the equipment proposed to be furnished as part of the Base Bid. One "X" and one "X" only shall be entered for each separate Base Bid category of material or equipment.

If the BIDDER marks more than one Base Bid manufacturer or fails to mark one where required for a particular piece of equipment or material, the BIDDER shall be required to furnish the equipment or material under the Contract as selected by the Owner from the listed Base Bid manufacturers.

Each BIDDER is required to follow these directions. Any bidding form that is submitted not in compliance with these directions may be rejected by the City of Massillon, and that Bid not considered in determining award.

<u>Specification Section</u>	<u>Manufacturer of Equipment or Material</u>	<u>Deduct From or Add to Base Bid</u>
26 24 19	Motor Control Centers Base Bid () a. Rockwell Automation, Allen Bradley Co., Industrial Control Group () b. Groupe Schneider / Square D () c. Eaton Corporation, Cutler Hammer Products	
26 29 23	Variable Frequency Motor Controllers Base Bid () a. Rockwell Automation Inc. / Allen Bradley	
35 20 16.1	Stainless Steel Hydraulic Gates Base Bid () a. Fontaine () b. WACO Products Inc. () c. Whipps Inc.	
35 20 16.2	Aluminum Hydraulic Gates Base Bid () a. WACO Products Inc. () b. Whipps Inc. () c. HydroGate	
40 91 00	Instrumentation General (Mag Meters) Base Bid () a. ABB	
40 91 31	Composite Sampling System Base Bid () a. Teledyne Isco Inc.	
40 92 13.13	Electrically Operated Primary Control Valves Base Bid () a. Rotork () b. Auma	
40 94 00	Programmable Controllers	

<u>Specification Section</u>	<u>Manufacturer of Equipment or Material</u>	<u>Deduct From or Add to Base Bid</u>
	Base Bid () a. Allen Bradley	
43 21 13.21	Vertical Non-Clog Centrifugal Pumps	
	Base Bid () a. Hayward Gordon	
43 21 36.41	Screw Pumps	
	Base Bid () a. EPIC International Incorporated () b. Evoqua Water Technologies	
43 21 39.11	Submersible Non-Clog Centrifugal Pumps	
	Base Bid () a. Flowserve () b. ABS () c. KSB	
43 21 39.23	Submersible Recirculator Chopper Pumps	
	Base Bid () a. Vaughan () b. Hayward Gordon	
44 31 21	Odor Control Biofilters	
	Base Bid () a. Evoqua Water Technologies	
46 21 43	Band Screens and Screening Washing Machines	
	Base Bid () a. HydroDyne Engineering () b. JWC Environmental	
46 33 42	Diaphragm-Type Metering Pumps	
	Base Bid () a. UGSI Chemical Feed (Encore 700)	
46 61 41	Disc Cloth Filters	
	Base Bid () a. WesTech Engineering	

09/23/2015

DECLARATION OF MANUFACTURER
00442-3

Specification
Section

Manufacturer of Equipment or Material

Deduct From or
Add to Base Bid

46 71 13

() b. Kruger, Inc.

Circular Gravity Thickeners

Base Bid

- () a. WesTech Engineering
- () b. ClearStream Environmental, Inc.
- () c. Monroe Environmental, Inc.
- () d. Amwell

END OF SECTION

SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Section includes:

<u>Article</u>	<u>Title</u>
1.2	Project Information
1.3	Work Covered by Contract Documents
1.4	Construction Contracts, This Project
1.5	Work By Owner
1.6	Work By Other Contracts
1.7	Access To Site
1.8	Coordination With Occupants
1.9	Work Restrictions
1.10	Specifications and Drawings Conventions
1.11	Notices to Owners and Authorities of Properties Adjacent to the Work

1.2 PROJECT INFORMATION

- A. Project Identification: City of Massillon, OH 2013 WWTP Improvements Project – Contract No. 2 - General Construction.
- B. Project Location: 100 Big Indian Dr SW, Massillon, OH 44646
- C. Project Design Engineer: CTI - O'Brien & Gere JV, 220 Market Ave South, Suite 750, Canton, OH 44702

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of the Project is defined by the Contract Documents and generally includes, but is not limited to, constructing the Work described below and all appurtenances related to the Work. The Work shall be as follows:
1. The project generally includes construction of the following: modifications to the existing Headworks facilities (influent screw pumps, odor control, flow monitoring, equalization, new fine screens), Primary Sludge modifications, a new Primary Effluent Pump Station (PEPS), Integrated Fixed Film Activated Sludge (IFAS) Biological Reactors (including Anaerobic/Anoxic /Oxic and Deoxic Zones), modifications of existing blower controls, modification to RAS piping, Addition of dedicated WAS pumping, Provisional Ferric Chloride Feed, replacement of the existing Tertiary Filter components, modifications to the existing Sludge Blending Tanks, Replacement of existing boilers for digester and building heating, Inter-Unit Piping Modifications, Electrical Service Distribution, Non-Potable Water pumping improvements, and associated site work.
 2. Contract No. 2 represents the general construction work, and includes the installation of the equipment systems purchased under Contract #1a – Integrated Fixed-Film Activated Sludge (IFAS) Equipment Procurement (Kruger) and Contract #1b – Primary Effluent Pump Station Equipment Procurement (Fairbanks Nijhuis).

3. Reference the Payment Items for additional summary of work.

1.4 CONSTRUCTION CONTRACTS, THIS PROJECT

- A. Project will be constructed under one contract:
 1. Contract No. 2 – General Construction

1.5 WORK BY OWNER

- A. General:
 1. Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner.
 2. Coordinate the Work of each Contract with work performed by Owner.
- B. Concurrent Work: Owner will perform the following construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract:
 1. Operate all existing valves, gates, pumps, equipment, and appurtenances that will affect Owner's operation, unless otherwise specified or indicated

1.6 WORK BY OTHER CONTRACTS

- A. General:
 1. Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts.
 2. Coordinate the Work of each Contract with work performed under separate contracts.
- B. Concurrent Work: Owner has awarded separate contracts for the following construction operations at Project sites. Those operations will be conducted simultaneously with work under this Contract:
 1. Contract No. 1a – Integrated Fixed-Film Activated Sludge (IFAS) Equipment Procurement
 2. Contract No. 1b – Primary Effluent Pump Station Equipment Procurement

1.7 ACCESS TO SITE

- A. General:
 1. Contractor shall have full use of Project sites for construction operations during construction period within project limits, as shown.
 2. Contractor's use of Project sites are limited only by Owner's right to perform work or to retain other contractors on portions of Project.
 3. Contractor shall move stored products that interfere with operations of Owner, other contractors, or others performing work for Owner.
- B. Use of Sites: Limit use of Project sites to areas within the Contract limits indicated. Do not disturb portions of Project sites beyond areas in which the Work is indicated.
 1. Limits: Confine construction operations to the limits indicated on the Contract Drawings.
 2. Driveways, Walkways and Entrances:
 - a. Keep driveways, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

- b. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - c. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site
- C. Easements and Right of Way:
 - 1. Easements and rights-of-way will be provided by Owner in accordance with the General Conditions.
 - 2. Confine construction operations to within Owner's property, public rights-of-way, easements obtained by Owner, and the limits shown.
 - 3. Use care in placing construction tools, equipment, excavated materials, and products to be incorporated into the Work to avoid damaging property and interfering with traffic.
 - 4. Do not enter private property outside the construction limits without permission from the owner of the property.

1.8 COORDINATION WITH OCCUPANTS

- A. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
 - 1. Engineer will prepare a Certificate of Partial Utilization for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
 - 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
 - 3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
 - 4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.9 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: In accordance with the General and Supplemental Conditions and City of Massillon Ordinances.
- C. Employee Identification: Provide identification tags for Contractor personnel working on the Project site. Require personnel to utilize identification tags at all times.

1.10 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These

conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on the Contract Drawings are described in detail in the Specifications. One or more of the following are used on the Contract Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations scheduled on Contract Drawings.

1.11 NOTICES TO OWNERS AND AUTHORITIES OF PROPERTIES ADJACENT TO THE WORK

- A. Notify owners of adjacent property and utilities when prosecution of the Work may affect their property, facilities, or use of property.
- B. When it is necessary to temporarily obstruct access to property, or when utility service connection will be interrupted, provide notices sufficiently in advance to enable affected persons to provide for their needs. Conform notices to Laws and Regulations and, whether delivered orally or in writing, include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.
- C. Notify utility owners and other concerned entities at least 48 hours prior to cutting or closing streets or other traffic areas or excavating near Underground Facilities or exposed utilities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 21 00
ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
 - 1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.
- B. Types of allowances include the following:
 - 1. Lump-sum allowances.
 - 2. Unit-cost allowances.
 - 3. Quantity allowances.
 - 4. Contingency allowances.
 - 5. Testing and inspecting allowances.
- C. Related Requirements:
 - 1. Section 01 45 00 "Quality Requirements" for procedures governing the use of allowances for testing and inspecting.

1.3 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Engineer of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
- B. At Engineer's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Engineer from the designated supplier.

1.4 ACTION SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.

1.5 INFORMATIONAL SUBMITTALS

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.6 COORDINATION

- A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.7 LUMP SUM, UNIT COST, AND QUANTITY ALLOWANCES

- A. Allowance shall include cost to the Contractor of specific products and materials ordered by the Owner or selected by the Engineer under allowance and shall include taxes, freight and delivery to the Project site.
- B. Unless otherwise indicated, the Contractor's costs for receiving and handling at the Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by the Owner or selected by the Engineer under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to the manufacturer or supplier for credit to the Owner, after installation has been completed and accepted.
 - 1. If requested by the Engineer, retain and prepare unused material for storage by the Owner. Deliver unused material to the Owner's storage space as directed.

1.8 CONTINGENCY ALLOWANCES

- A. Use the contingency allowance only as directed by the Engineer for the Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.
- C. Contractor's overhead, profit and related costs for products and equipment ordered by the Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.
- D. Change Orders authorizing use of funds from the contingency allowance will include the Contractor's related costs and reasonable overhead and profit margins.
- F. At Project closeout, credit unused amounts remaining in the contingency allowance to the Owner by Change Order.

1.9 (NOT USED)

1.10 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.
 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
 3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
 4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
1. Do not include the Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
 2. No change to the Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

END OF SECTION

SECTION 01 23 00

ALTERNATES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Administrative and procedural requirements for selecting equipment for the Project.
2. Procedural requirements for equipment substitutions.
3. Procedural requirements for substitute construction methods or procedures, when construction methods or procedures are specified.

1.2 EQUIPMENT SUBSTITUTIONS

A. Contractor shall submit a request for substitution to the Engineer for review. In addition to the requirements in the General Conditions, the Contractor shall include the following information in their request:

1. Product identification, including manufacturer's name and address.
2. Manufacturer's literature with equipment description, performance and test data, and reference standards with which the equipment complies.
3. Samples, if appropriate.
4. Name and address of similar projects on which equipment was used, and date of installation.

B. Contractor shall submit a separate request for each substitution.

1.3 SUBSTITUTE CONSTRUCTION METHODS OR PROCEDURES

A. Contractor shall submit a request for substitution to the Engineer for review. In addition to the requirements in the General Conditions, the Contractor shall include the following information in their request:

1. Detailed description of proposed construction method or procedure.
2. Itemized comparison of the proposed substitution with the specified method or procedure.
3. Drawings illustrating the construction method or procedure.
4. Other data required by the Engineer to establish that the proposed substitution is equivalent to the specified construction method or procedure.

B. Contractor shall submit a separate request for each substitution.

1.4 CONTRACTOR'S REPRESENTATION AND ACCEPTANCE

A. In making a request for substitution, the Contractor represents that:

1. Contractor has investigated the proposed substitution and determined that it is equivalent to the equipment, method, or procedure specified, as applicable.
2. Contractor will provide the same or better guarantees or warranties for the proposed substitution as for the specified equipment, manufacturer, method, or procedure, as

applicable.

3. Contractor waives all Claims for additional costs or extension of time related to the proposed substitution that subsequently may become apparent.
- B. A proposed substitution will not be accepted if:
1. Acceptance will require changes in the design concept or a substantial revision of the Contract Documents.
 2. Acceptance will delay completion of the Work or the work of other contractors.
 3. Substitution request is indicated or implied on a Shop Drawing or a request for interpretation or clarification and is not accompanied by Contractor's formal request for substitution.
- C. If the Engineer determines that the proposed substitute is not acceptable, Contractor shall provide the specified equipment manufacturer, method, or procedure as applicable.
- D. Approval of a substitution request will not relieve the Contractor from the requirement to submit Shop Drawings as set forth in the Contract Documents

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 01 21 00 "Allowances".
 - 2. Section 01 23 00 "Alternates", for products selected under an alternate.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by the Contractor.
 - 1. Substitutions for Cause: Changes proposed by the Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by the Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to the Contractor or Owner.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use CSI Form 13.0B, unless another form is provided by the owner for this purpose.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by the Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Certificates and qualification data, where applicable or requested.
 - f. List of similar installations for completed projects with project names and addresses and names and addresses of engineers and owners.
 - g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - h. Detailed comparison of the Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from the manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - i. Cost information, including a proposal of change, if any, in the Contract Sum.
 - j. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - k. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. The Engineer will notify the Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of

related submittals.

1. Conditions: Engineer will consider the Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect the Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Not allowed unless otherwise indicated.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 73
SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Submit to the Engineer for acceptance a Schedule of Values that allocates cost to each item of the Work. The Schedule of Values is a list of line items, corresponding to each aspect of the Work, establishing in detail the value or cost of each major part of the Work.
- B. Upon request from the Engineer, provide supporting data or documentation that substantiates the correctness of the Schedule of Values
- C. The preliminary Schedule of Values is submitted to the Engineer for initial review. The Contractor shall incorporate the Engineer's comments into the Schedule of Values and provide a re-submittal to the Engineer. The Engineer may require corrections and re-submittal of the Schedule of Values until it is acceptable.
- D. The Schedule of Values shall be used as the basis for preparing each Application for Payment. The Schedule of Values may be used as a basis for negotiating the price of changes in the Work.
- E. The Schedule of Values shall include an itemized list of Work for each payment item as listed in the Bid Form
- F. Unit price payment items with their associated quantity shall be included in the Schedule of Values. When required by the Engineer, provide a detailed breakdown of the unit price payment items in the Schedule of Values.
- G. Schedule of Values requirements are listed below. Requirements for the preliminary Schedule of Values and the final Schedule of Values are identical:
 - 1. Schedule of Values shall include a breakdown of costs for materials and equipment, installation, and other costs used in preparation of the Bid by the Contractor. Schedule of Values shall include the purchase and delivery cost for materials and equipment for which the Contractor may apply for payment as stored materials.
 - 2. Include separate amounts for each Specification section in the Contract Documents and for each structure, building, and work area.
 - 3. Identify each line item with a number corresponding to the associated Specification section number. List sub-items of major equipment or systems, as appropriate or when requested by the Engineer.
 - 4. Include a separate line item for each unit price item.
 - 5. Contractor shall include a separate line item for mobilization. Document for the Engineer the work activities included in the mobilization line items.
 - 6. Include a line item for bonds and insurance in the mobilization payment item. Payment for this line item may be applied for in the first Application for Payment.
 - 7. Contractor shall include items for Project Schedule, General Conditions, and other items requested by the Engineer. These items shall be included in Applications for Payment on a schedule proposed by the Contractor and approved by the Engineer.
 - 8. Each line item shall include a directly proportional amount of the Contractor's overhead and profit. The Contractor shall not include overhead and profit as a separate line item.

9. The sum of the individual values shown on the Schedule of Values shall equal the total of the associated payment item. The sum of the payment item totals in the Schedule of Values shall equal the Contract Price.

1.2 SUBMITTALS

- A. Submit the required number of copies of the preliminary Schedule of Values to the Engineer for review within ten days after the Notice to Proceed.
- B. Submit the required number of copies of the Final Schedule of Values to the Engineer at least twenty days prior to the first Application for Payment. The first Application for Payment will not be processed without a Final Schedule of Values approved by the Engineer.
- C. When required by the Engineer, promptly submit an updated Schedule of Values to include cost breakdowns for changes in the Work, including Change Orders.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 00

PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. Requests for Information (RFIs).
 - 4. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
 - 1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

- A. RFI: Request from the Owner, Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at the Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to the Project.
 - 1. Post copies of list in the project meeting room, in the temporary field office and by each

temporary telephone. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for the Owner and separate contractors if coordination of their Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of the Contractor's construction schedule.
 - 2. Preparation of the schedule of values.
 - 3. Installation and removal of temporary facilities and controls.
 - 4. Delivery and processing of submittals.
 - 5. Progress meetings.
 - 6. Preinstallation conferences.
 - 7. Project closeout activities.
 - 8. Startup and adjustment of systems.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 - 1. Salvage materials and equipment involved in performance of, but not actually

incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as the Owner's property.

1.6 COORDINATION DRAWINGS

- A. General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - c. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - d. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - e. Indicate required installation sequences.
 - f. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to the Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
 2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. Mechanical and Plumbing Work: Show the following:

- a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
- 7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches (32 mm) in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
- 8. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
- 9. Review: Engineer will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are the Contractor's responsibility. If the Engineer determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, the Engineer will so inform the Contractor, who shall make changes as directed and resubmit.
- 10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 01 33 00 "Submittal Procedures."

1.7 REQUESTS FOR INFORMATION (RFIS)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, the Contractor shall prepare and submit an RFI in the form specified.
 - 1. Engineer will return RFIs submitted to the Engineer by other entities controlled by the Contractor with no response.
 - 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in the Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 - 1. Project name.
 - 2. Project number.
 - 3. Date.
 - 4. Name of Contractor.
 - 5. Name of Engineer.
 - 6. RFI number, numbered sequentially.
 - 7. RFI subject.
 - 8. Specification Section number and title and related paragraphs, as appropriate.
 - 9. Drawing number and detail references, as appropriate.

10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If the Contractor's suggested resolution impacts the Contract Time or the Contract Sum, the Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms:
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow 7 working days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of the Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Engineer's action may include a request for additional information, in which case the Engineer's time for response will date from time of receipt of additional information.
 3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for the Contractor to submit Change Proposal.
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify the Engineer in writing within 10 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Engineer.
 4. RFI number including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Engineer's response was received.
- F. On receipt of the Engineer's action, update the RFI log and immediately distribute the RFI

response to affected parties. Review response and notify the Engineer within 7 days if the Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.8 PROJECT MEETINGS

- A. General: Engineer will schedule and conduct meetings and conferences at the Project site unless otherwise indicated.
 1. Attendees: Engineer will inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify the Owner and Engineer of scheduled meeting dates and times.
 2. Agenda: Engineer will prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Contractor, within 5 days of the meeting.
- B. Preconstruction Conference: Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to the Owner and Engineer, but no later than 15 days after execution of the Agreement.
 1. Conduct the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of the Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.
 - j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Preparation of record documents.
 - m. Use of the premises
 - n. Work restrictions.

- o. Working hours.
- p. Owner's occupancy requirements.
- q. Responsibility for temporary facilities and controls.
- r. Procedures for moisture and mold control.
- s. Procedures for disruptions and shutdowns.
- t. Construction waste management and recycling.
- u. Parking availability.
- v. Office, work, and storage areas.
- w. Equipment deliveries and priorities.
- x. First aid.
- y. Security.
- z. Progress cleaning.
- 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Contractor shall conduct a preinstallation conference at the Project site before each construction activity that requires coordination with other construction.
 - 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise the Engineer of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility requirements.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written instructions.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.

- q. Temporary facilities and controls.
- r. Space and access limitations.
- s. Regulations of authorities having jurisdiction.
- t. Testing and inspecting requirements.
- u. Installation procedures.
- v. Coordination with other work.
- w. Required performance results.
- x. Protection of adjacent work.
- y. Protection of construction and personnel.
- 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
- 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
- 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Engineer will schedule and conduct a project closeout conference, at a time convenient to the Owner, but no later than 90 days prior to the scheduled date of Substantial Completion.
 - 1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 - 2. Attendees: Authorized representatives of the Owner, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for preparing operations and maintenance data.
 - e. Requirements for delivery of material samples, attic stock, and spare parts.
 - f. Requirements for demonstration and training.
 - g. Preparation of the Contractor's punch list.
 - h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - i. Submittal procedures.
 - j. Coordination of separate contracts.
 - k. Owner's partial occupancy requirements.
 - l. Installation of Owner's furniture, fixtures, and equipment.

- m. Responsibility for removing temporary facilities and controls.
- 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress and Coordination Meetings: Engineer will conduct progress and coordination meetings at regular intervals.
 - 1. Attendees: In addition to representatives of the Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of the Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to the Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site utilization.
 - 9) Temporary facilities and controls.
 - 10) Progress cleaning.
 - 11) Quality and work standards.
 - 12) Status of correction of deficient items.
 - 13) Field observations.
 - 14) Status of RFIs.
 - 15) Status of proposal requests.
 - 16) Pending changes.
 - 17) Status of Change Orders.
 - 18) Pending claims and disputes.
 - 19) Documentation of information for payment requests.

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3. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Contractor shall revise the construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 00

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Contractor's construction schedule.
- B. Requirements in this Section are in addition to those specified in the General Conditions.

1.2 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Price, unless otherwise approved by Engineer.
- C. CPM- Critical path method: a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of the Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration.
- E. Event: The starting or ending point of an activity.
- F. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.3 INFORMATION SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF electronic file.
- B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working electronic copy of the schedule, using software indicated. Schedule shall be labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- C. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date,

and late finish date.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 3. Earnings Report: Compilation of Contractor's total earnings from Notice to Proceed until most recent Application for Payment.
- D. Qualification Data: For scheduling consultant.

1.4 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams as specified herein.
- B. Prescheduling Conference: Review methods and procedures related to the Contractor's construction schedule, including, but not limited to, the following:
 1. Review software limitations and content and format for reports.
 2. Verify availability of qualified personnel needed to develop and update schedule.
 3. Discuss constraints, including interim Milestones and Partial Utilization.
 4. Review delivery dates for Owner-furnished products.
 5. Review schedule for work of Owner's separate contracts.
 6. Review time required for review of submittals and resubmittals.
 7. Review requirements for tests and inspections by independent testing and inspecting agencies.
 8. Review time required for completion and startup procedures.
 9. Review and finalize list of construction activities to be included in schedule.
 10. Review submittal requirements and procedures.
 11. Review procedures for updating schedule.

1.5 COORDINATION

- A. General Contractor shall incorporate detailed schedules prepared by other contractors into the overall Progress Schedule, and shall maintain throughout duration of Project
- B. Coordinate preparation and processing of schedules and reports with the performance of construction activities and with the scheduling and reporting of separate contractors.
- C. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 1. Secure time commitments for performing critical elements of the Work from entities involved.
 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

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CONSTRUCTION PROGRESS DOCUMENTATION

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE (GENERAL)

- A. Time Frame: Extend schedule from date established for Notice to Proceed to date of Final Completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Engineer.
 - 2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - 3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 - 4. Startup and Testing Time: Include appropriate durations for startup and testing.
 - 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
 - 6. Punch List and Final Completion: Include preparation of punch lists and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected
 - 1. Work under More Than One Contract: Include separate activities for each contract.
 - 2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 - 3. Owner-Furnished Products: Include a separate activity for each product.
 - 4. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.

- k. Curing.
 - l. Startup, commissioning and placement into final use and operation.
- 5. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion.
 - b. Permanent space enclosure.
 - c. Completion of mechanical installation.
 - d. Completion of electrical installation.
 - e. Substantial Completion.
- 6. Other Constraints: As may apply.
- D. Milestones: Include milestones indicated in the Contract Documents in the schedule.
 - 1. Contractor shall schedule work such that any specified intermediate milestone dates and completion dates are met as specified in the contract documents.
- E. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On this line, show dollar volume of the Work performed as of dates used for preparation of payment requests.
- F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 - 1. Unresolved issues.
 - 2. Unanswered RFIs.
 - 3. Rejected or unreturned submittals.
 - 4. Notations on returned submittals.
- G. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and the date by which recovery will be accomplished.
- H. Computer Scheduling Software: Prepare schedules using the current version of a program that has been developed specifically to manage construction schedules.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. CPM Schedule: Prepare Contractor's construction schedule using a cost- and resource-loaded, time-scaled CPM network analysis diagram for the Work.
 - 1. Develop the network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date of the Notice of Award.
 - a. Failure to include any work item required for performance of this Contract shall not excuse the Contractor from completing all work within applicable completion dates, regardless of Engineer's approval of the schedule.
 - 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 - 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 - 4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to correlate with Contract Time.
- C. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the start-up network diagram, prepare a skeleton network to identify probable critical paths.
 - 1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by the Contractor's activities.
 - i. Testing and commissioning.
 - j. Punch list and final completion.
 - k. Activities occurring following final completion.
 - 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract Milestone dates.
 - 3. Sequence of Operation: The schedule shall provide and show a sequence of operations that maintain continuous operation of the existing plant during the construction operations, except as otherwise indicated, including the constraints and restrictions set forth in the General and Supplemental Conditions.
 - 4. Special inspections: The Contractor shall incorporate any special inspections required by

building code into the CPM Schedule and provide a minimum of two-week advance notice to the Owner / Engineer of a requirement.

5. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
6. Format: Mark the critical path. Locate the critical path near center of network.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
7. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Engineer's approval prior to assigning costs to fabrication and delivery activities. Assign costs under principal subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Price.
 - a. Each activity cost shall reflect an appropriate value subject to approval by Engineer.
 - b. Total cost assigned to activities shall equal the total Contract Price.
- D. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.
- E. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start". Identify critical activities. Prepare tabulated reports showing the following:
 1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Principal events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Average size of workforce.
 9. Dollar value of activity (coordinated with the schedule of values).
- F. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
 1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in the Contract Time.
- G. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
 1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.

2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts one week before each regularly scheduled progress meeting.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling
 1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
 2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- B. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.
- C. Distribution: Distribute copies of approved schedule to Engineer, Construction Manager, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

SECTION 01 32 33

PHOTOGRAPHIC AND VIDEO DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Periodic construction photographs.
 - 3. Final completion construction photographs.
 - 4. Preconstruction video recordings.
 - 5. Periodic construction video recordings.

1.2 RELATED REQUIREMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section, including but not necessarily limited to:
 - 1. Section 01 33 00 "Submittal Procedures" for submitting photographic documentation.
 - 2. Section 01 77 00 "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.

1.3 QUALITY ASSURANCE

- A. Photographer Qualifications:
 - 1. Photographer shall be a specialist regularly engaged in professional photography and experienced in photographing construction sites
 - 2. Upon request of Engineer submit documentation of having successfully performed photographic documentation for at least five previous construction projects, each lasting at least five months.
- B. Engineer will approve the views to be taken and select time at which images will be taken. Photographic subjects, views, and angles will vary with progress of the Work.

1.4 SUBMITTALS

- A. Submit the following in accordance with Specification 01 33 00 Submittal Procedures.
- B. Informational Submittals: Submit the following:
 - 1. Key Plan: Submit a proposed key plan of the Project site and building with notation of vantage points marked for location and direction of photographs. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
 - 2. Pre-construction Photographic Documentation: Submit acceptable pre-construction photographic documentation (prints and discs) prior to mobilizing to and disturbing the Site. Provide pre-construction photographic documentation no later than first Application for Payment, unless other schedule is accepted by Engineer.

3. Construction Progress Photographic Documentation: Submit acceptable construction progress photographic documentation (prints and discs) monthly. Submit with each Application for Payment, unless otherwise agreed to by Engineer.
4. Qualifications Statements:
 - a. When requested by Engineer, submit photographer qualifications and record of experience, prior to starting photographic documentation Work. List of construction photography experience shall include the following for each project: project name and location, nature of construction, photographer's client with contract information, and approximate duration of project.
5. Closeout Submittals: Submit the following:
 - a. Final Photographic Documentation: Submit acceptable final photographic documentation (prints and discs) prior to submitting final Application for Payment.

1.5 PHOTOGRAPHIC DOCUMENTATION, GENERAL

- A. Photographic Prints:
 1. Quantity: For each photograph taken, provide to Engineer two prints.
 2. Print Size and Finish:
 - a. Submit 8-inch by 10-inch prints on professional-grade, minimum nine-mil thick, photograph paper with semi-gloss or satin finish, enclosed back to back in clear plastic sleeves that are punched for standard three-ring binder, unless otherwise specified.
 - b. Aerial Photographs: Provide 20-inch by 24-inch prints on professional-grade, minimum nine-mil thick, photograph paper with satin finish.
 3. Include the following information on back of each print and front of each disc containing photographic documentation:
 - a. Name of Project.
 - b. Name of Owner,
 - c. Name of Project Site,
 - d. Date photograph was taken, if not date stamped by camera,
 - e. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction,
 - f. Description of view shown in photograph,
 - g. Unique sequential identifier keyed to accompanying key plan,
 - h. Name and contact information for photographer.
- B. Digital Files of Photographs:
 1. Digital Camera: Minimum sensor resolution of 8 megapixels.
 2. Format: For each photograph taken, provide high-quality digital image on compact disc (CD) in "JPG" file format, each photo a minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, un-cropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file
 3. Identification: Provide the following information with each image description in file metadata tag:

- a. Name of Project.
 - b. Name of Owner.
 - c. Name of Project Site
 - d. Date photograph was taken, if not date stamped by camera.
 - e. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - f. Description of view shown in photograph.
 - g. Unique sequential identifier keyed to accompanying key plan.
 - h. Name and contact information for photographer.
4. Electronic image filename shall describe the image; do not submit filenames automatically created by digital camera. For example, an acceptable electronic filename would be, "Dewatering Building – Looking West at Centrifuge No. 2.jpg"

1.6 VIDEOGRAPHY DOCUMENTATION, GENERAL:

- A. Video shall be high-resolution, high-quality video of the Site and Project work in standard DVD-R format.
- B. Provide three copies of each video disc.
- C. Recording: Mount camera on tripod before starting recording unless otherwise necessary to show area of construction. Display continuous running time and date. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.
- D. Narration: Describe scenes on video recording by either audio narration by microphone while recording or dubbing audio narration off-site after recording is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.
 1. Confirm date and time at beginning and end of recording.
 2. Begin each video recording with name of Project, Contractor's name, videographer's name, and Project location.
- E. Transcript: Provide a typewritten transcript of the narration. Display images and running time captured from video recording opposite the corresponding narration segment.
- F. Preconstruction Video Recording: Before starting construction, record video recording of Project site and surrounding properties from different vantage points, as directed by Engineer.
 1. Flag construction limits before recording construction video recordings.
 2. Show existing conditions adjacent to Project site before starting the Work.
 3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of construction.
 4. Show protection efforts by Contractor.
- G. Periodic Construction Video Recordings: Record video recording each time photographer is on site. Select vantage points to show status of construction and progress since last video recordings were recorded. Minimum recording time shall be thirty (30) minutes.
- H. Vantage Points: Following suggestions by Engineer and Contractor, photographer shall select vantage points.

1.7 PRE-CONSTRUCTION PHOTOGRAPHIC DOCUMENTATION

- A. Pre-Construction Photographic Documentation:
1. Obtain and submit sufficient pre-construction photographic documentation to record Site conditions prior to construction. Photographs shall document all work areas of all prime contracts.
 2. Submit a minimum of forty (40) pre-construction photographs. Pre-construction photographs are not part of required number of construction progress photographs specified in Article 1.6 of this Section.
 3. Provide pre-construction video of all work areas included in all prime contracts on the Project, including indoor and outdoor work areas and staging areas. Preconstruction video shall be minimum thirty (30) minutes, or sufficient length to cover entire project work sites and areas.
 4. Provide pre-construction aerial photographs of the Site. Submit one oblique photograph taken from each cardinal direction (north, south, east, and west), from each project site. Obtain permits or permission, as applicable, for required flyovers.
- B. If disagreement arises on condition of the Site and insufficient pre-construction photographic documentation was submitted prior to the disagreement, restore the grounds or area in question to extent directed by Engineer and to complete satisfaction of Engineer.

1.8 CONSTRUCTION PROGRESS PHOTOGRAPHIC DOCUMENTATION

- A. Progress Photographs:
1. Take photographs bi-weekly for the entire duration of the project.
 2. Take at least fifteen (15) photographs each time photographer is at the Site, Select vantage points to show status of construction and progress since last photographs were taken.
 3. Maximum number of progress photographs required will be five hundred (250), based on the Contract Times and scope of Project on date Contract Times commence running. Proportionately modify amount of photographic documentation if scope of Project or Contract Times are modified.
 4. Provide interior and exterior photographic documentation of each structure as directed by Engineer at the time photographic documentation is taken.
 5. Time-Lapse Sequence Construction Photographs: Take photographs as indicated, to show status of construction and progress since last photographs were taken.
 - a. Frequency: Take bi-weekly, with timing each month adjusted to coincide with the cutoff date associated with each Application for Payment.
 - b. Vantage Points: Following suggestions by the Engineer and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than 2 of the required shots from same vantage point each time to create a time-lapse sequence as follows:
 - 1) Commencement of the Work, through completion of subgrade construction.
 - 2) Above-grade structural framing.
 - 3) Exterior building enclosure.
 - 4) Interior Work, through date of Substantial Completion.
- B. Videography:

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1. Obtain a construction progress video each time photographer is at the Site.
2. Construction progress videography shall cover all areas of work under each prime contract since the previous video was taken.

1.9 FINAL PHOTOGRAPHIC DOCUMENTATION

A. Final Photographs:

1. Take photographs at time and day acceptable to Engineer. Do not take final photographs prior to Substantial Completion. Work documented in final photographs shall be generally complete, including painting and finishing, furnishings, landscaping, and other visible Work.
2. Take at least forty (40) final photographs, based on scope of the Project at the time Contract Times commence running. Final photographs are not part of construction progress photographs required.
3. Provide aerial photographs of the Site following completion of restoration and landscaping, with final photographic documentation submittal. Provide one oblique photograph taken from each cardinal direction (north, south, east, and west), from each project site. Obtain permits or permission, as applicable, for required flyovers

B. Video:

1. Record final video at same time that final photographs are taken.
2. Final videography shall cover all areas of the Project.

1.10 USAGE RIGHTS

- A. Obtain and transfer copyright usage rights from photographer to the Owner for unlimited reproduction of project photographic documentation.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section includes requirements for the submittal schedule and the administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals. Contractor shall provide submittals in accordance with the General Conditions as modified by the Supplementary Conditions, and this Section.

1.2 SCOPE

- A. Provide submittals well in advance of need for the material or equipment, or procedure (as applicable), in the Work and with ample time required for delivery of material or equipment and to implement procedures following Engineer's approval or acceptance of the associated submittal. Work covered by a submittal will not be included in progress payments until approval or acceptance of related submittals has been obtained in accordance with the Contract Documents.
- B. Contractor is responsible for dimensions to be confirmed and corrected at the Site, for information pertaining solely to the fabrication processes and to techniques of construction, and for coordinating the work of all trades. Contractor's signature of submittal's stamp and letter of transmittal shall be Contractor's representation that Contractor has met his obligations under the Contract Documents relative to that submittal.
- C. Samples:
 - 1. Conform submittal of Samples to the General Conditions as modified by the Supplementary Conditions, this Section, and the Specification Section in which the Sample is specified.
 - 2. Furnish at the same time Samples and submittals that are related to the same unit of Work or Specification Section. Engineer will not review submittals without associated Samples, and will not review Samples without associated submittals.
 - 3. Samples shall clearly illustrate functional characteristics of product, all related parts and attachments, and full range of color, texture, pattern, and material.

1.3 DEFINITIONS

- A. Submittals are classified as follows: 1) Action Submittals, 2) Informational Submittals, 3) Closeout Submittals, and 4) Operations and Maintenance Material submittals. Type of each required submittal is designated in the respective Specification Sections; when type of submittal is not specified in the associated Specification Section, submittal will be classified as follows:
 - 1. Action Submittals:
 - a. Written/graphic information and physical samples that require Engineer's responsive action, such as shop drawings, product data, testing plans, procedures, and testing limitations.
 - b. Delegated design submittals, which include documents prepared, sealed, and signed by a design professional retained by Contractor, Subcontractor, or Supplier

for materials and equipment to be incorporated into the completed Work.

2. Informational Submittals:
 - a. Written/graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.
 - b. Pre-construction test and evaluation reports, such as reports on pilot testing, subsurface investigations, potential Hazardous Environmental Condition, and similar reports.
 - c. Supplier instructions, including installation data, and instructions for handling, storage, starting-up and troubleshooting.
 - d. Source quality control submittals (other than testing plans, procedures, and testing limitations), including results of shop testing.
 - e. Field or Site quality control submittals (other than testing plans, procedures, and testing limitations), including results of installation, start-up, operating and acceptability tests at the Site.
 - f. Special procedure submittals, including health and safety plans and other procedural submittals.
 - g. Design data not sealed and signed by a design professional retained by CON Contractor, Subcontractor, or Supplier.
3. Closeout Submittals:
 - a. Maintenance contracts.
 - b. Operations and maintenance data.
 - c. Bonds, such as maintenance bonds and bonds for a specific product or system.
 - d. Warranty documentation.
 - e. Record documentation.
 - f. Sustainable design closeout documentation.
 - g. Software.
4. Maintenance Material Submittals include:
 - a. Spare parts. Where the Technical Specification Sections of this Contract require spare parts to be furnished by the Contractor, said spare parts for each item of equipment shall be kept separate and tagged to identify the specific item of equipment to which they belong, shall be packaged so as to preclude damage from handling and storage, and shall be bagged or packaged together where items are small in dimension.
 - b. Extra stock materials.
 - c. Tools. The Contractor shall, unless otherwise stated, furnish with each type, kind, and size of equipment, one complete set of any special tools and appliances which may be needed to adjust, operate, maintain, or repair the equipment.
 - d. Each piece of equipment shall be provided with a substantial nameplate, which is securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, and principal rating data.
5. When type of submittal is not specified and is not included in the list above, Engineer will determine the type of submittal

- B. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- C. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 SUBMITTALS REQUIRED, THIS SECTION

- A. Informational Submittals: Provide the following:
 - 1. Schedule of Submittals:
 - a. Contractor shall submit a schedule of submittals, arranged in chronological order by dates required by the construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or modifications to submittals noted by the Engineer and additional time for handling and reviewing submittals required by those corrections.
 - b. Timing:
 - 1) Initial Submittal shall be submitted concurrently with the start-up construction schedule prior to the required Preconstruction Meeting. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - 2) Provide updated Schedule of Submittals with each submittal of the updated Progress Schedule.
 - c. Format: Arrange the following information in a tabular format:
 - 1) Scheduled date for first submittal.
 - 2) Specification Section number and title.
 - 3) Submittal category: Action, Informational.
 - 4) Name of subcontractor.
 - 5) Description of the Work covered.
 - 6) Scheduled date for Engineer's final release or approval.
 - 7) Scheduled dates for purchasing.
 - 8) Scheduled dates for installation.
 - d. Content: Identify on Schedule of Submittals all submittals required in the Contract Documents. Updates of Schedule of Submittals shall show scheduled dates and actual dates for completed tasks. Indicate submittals that are on the Project's critical path. Indicate the following, at a minimum, for each submittal:
 - 1) Date by which submittal will be provided to Engineer.
 - 2) Whether submittal will be for a "substitution" or "equal". Procedures for substitutions and "or equals" are specified in the General Conditions and the Division 01 Specifications.

- 3) Date by which Engineer's response is required. At least fifteen (15) days shall be allowed from Engineer's receipt of each submittal. Allow increased time for large or complex submittals.
 - 4) For submittals for materials or equipment, date by which material or equipment must be at the Site to avoid delaying the Work and to avoid delaying the work of other contractors.
- e. Prepare and coordinate the Schedule of Submittals using same software, and in same format, as specified for Progress Schedules.

1.5 SUBMITTAL PROCEDURES

- A. Submittal Identification and Information: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file with links enabling navigation to each item.
 2. Name each file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number. Re-submittals shall include an alphabetic suffix after another decimal point.
 3. Provide means to permanently record the Contractor's review and approval markings and action taken by the Engineer or Construction Manager.
 4. Include the following information on an inserted cover sheet:
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Name of firm or entity that prepared submittal.
 - g. Name of subcontractor.
 - h. Name of supplier.
 - i. Name of manufacturer.
 - j. Number and title of appropriate Specification Section.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.
 - n. Other necessary identification.
 5. Include the following information as keywords in the electronic file metadata:
 - a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.

- d. Product name.
- B. Contractor's Review and Stamp:
 - 1. Before transmitting submittals to Engineer, review submittals to:
 - a. assure proper coordination of the Work;
 - b. determine that each submittal is in accordance with CONTRACTOR's desires;
 - c. verify that submittal contains sufficient information for ENGINEER to determine compliance with the Contract Documents.
 - 2. Each submittal provided shall bear Contractor's stamp of approval and signature, as evidence that submittal has been reviewed by Contractor and verified as complete and in accordance with the Contract Documents.
 - 3. Submittals that are incomplete, inadequate, or without Contractor's stamp and signature will be returned without review. Signatures that appear to be computer-generated will be regarded as unsigned and the associated submittal will be returned without review.
- C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate the preparation and processing of submittals with the performance of construction activities.
 - 2. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 3. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 - 4. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 - 5. Coordinate the transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of the need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- D. Processing Time: Time for review shall commence on Engineer's receipt of submittal. The failure to transmit submittals in sufficient notice of the Work to permit processing, including re-submittals, shall not serve as authorization for an extension of Contract Time. Allow time for submittal review, including time for re-submittals as follows:
 - 1. Initial Review: Allow fifteen (15) working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Intermediate Review: If intermediate submittal is necessary, process it in the same manner as the initial submittal.
 - 3. Re-submittal Review: Allow fifteen (15) working days for review of each re-submittal.
- E. Options: Identify options requiring selection by the Engineer.
- F. Deviations: Identify deviations from the Contract Documents on submittals.
- G. Transmittal: Assemble each submittal individually and appropriately for transmittal and

handling. Transmit each submittal using a transmittal form. Engineer will return submittals without review, received from sources other than Contractor.

1. Transmittal Form: Provide locations on form for the following information:
 - a. Project name.
 - b. Date.
 - c. Destination (To:).
 - d. Source (From:).
 - e. Names of subcontractor, manufacturer, and supplier.
 - f. Category and type of submittal.
 - g. Submittal purpose and description.
 - h. Specification Section number and title.
 - i. Indication of full or partial submittal.
 - j. Drawing number and detail references, as appropriate.
 - k. Transmittal number, numbered consecutively.
 - l. Submittal and transmittal distribution record.
 - m. Remarks.
 - n. Signature of transmitter.
 2. On an attached separate sheet, prepared on the Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by the Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- H. Re-submittals shall be in the same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction and any others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Use only final submittals that are marked with approval notation from Engineer's action stamp.

1.6 SUBMITTAL REQUIREMENTS

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Submit electronic submittals as PDF files via Prolog Converge (Project site to be set up and provided by the Engineer).
 - a. Engineer will return annotated file. Annotate and retain one copy of the file as an

electronic Project record document file.

2. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in the Section entitled "Closeout Procedures."
 3. Certificates and Certifications Submittals: Provide a statement that includes the signature of the entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
 4. Test and Inspection Reports Submittals: Comply with requirements specified in the Section entitled "Quality Requirements."
 5. Number of Submittal Copies: Provide a minimum of 2 hard copies and 1 electronic copy of all submittals. One (1) hard copy will be kept at the Engineer's Field Office, (1) hard copy will be provided to the Owner. The electronic copy will be returned to the Contractor. If the Contractor desires hard copies returned to it, it shall submit with the initial and any subsequent resubmittals the additional number desired up to a maximum of three copies. Provide additional copies of submittals if required elsewhere in the Contract Documents. Reference Section entitled "Operation and Maintenance Data" for specific requirements pertaining to Operation and Maintenance Manual number of copies and submittal procedures."
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop

Drawings.

5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:
 - a. PDF electronic file.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless the submittal based upon the Engineer's digital data drawing files is otherwise permitted.
 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
 3. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit two full set(s) of available choices where color, pattern,

texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit three sets of Samples. Engineer will retain two Sample sets; remainder will be returned.
 - i. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - ii. If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Product Schedule: As required in individual Specification Sections, a written summary shall be prepared, indicating the types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product, including a unique identifier for each product indicated in the Contract Documents.
 2. Manufacturer's name, product name and model number if applicable.
 3. Number and name of the room or space in which product will be installed.
 4. Location within room or space, in which product will be installed.
 5. Submit product schedule in PDF format.
- F. Contractor's Construction Schedule: Comply with requirements specified in the Section entitled "Construction Progress Documentation."
- G. Application for Payment: Comply with requirements specified in General Conditions.
- H. Schedule of Values: Comply with requirements specified in General Conditions.
- I. Subcontract List: Prepare a written summary identifying individuals or firms responsible for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 1. Name, address, and telephone number of the entity performing subcontract or supplying products.
 2. Number and title of related Specification Section(s) covered by the subcontract.
 3. Drawing number and detail references, as appropriate, covered by the subcontract.
 4. Submit subcontract list in PDF format.
- J. Qualification Data: Prepare written information that demonstrates capabilities and experience of the firm or person. Include lists of completed projects with project names and addresses, contact information of Engineer and Owner, and other information specified.

- K. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on American Welding Society (AWS) forms. Include names of firms and personnel certified.
- L. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that the Installer complies with the requirements in the Contract Documents and, where required, is authorized by the manufacturer for this specific Project.
- M. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that the manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- N. Product Certificates: Submit written statements on manufacturer's letterhead certifying that the product complies with requirements in the Contract Documents.
- O. Material Certificates: Submit written statements on manufacturer's letterhead certifying that the material complies with requirements in the Contract Documents.
- P. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of the material for compliance with the requirements in the Contract Documents.
- Q. Product Test Reports: Submit written reports indicating that the current product produced by the manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- R. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for the Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- S. Schedule of Tests and Inspections: Comply with requirements specified in the Section entitled "Quality Requirements."
- T. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- U. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- V. Field Test Reports: Submit reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- W. Maintenance Data: Comply with requirements specified in Division 01 Section "Operation and

Maintenance Data."

- X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

1.7 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request to the Engineer for additional information.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit a digitally-signed PDF electronic file and three paper copies of the certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to the Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.8 ENGINEER'S ACTION

- A. General: Engineer will not review submittals that do not bear the Contractor's approval stamp and will return them without action.
- B. The Engineer's review of shop drawings is for general compliance with the Contract Documents only and is not a complete check of the method of assembly, erection, construction or detailed review of the specifications. Such review shall in no way be construed as permitting any departure whatsoever from the Contract Documents, except where the Contractor has previously requested and received written approval of the Engineer for such departure. When requested by Contractor, proposed departures from the Contract Documents will be considered by Engineer at Contractor's expense, whether or not accepted. The cost of Engineer's conflict review and any revisions made as a result of Contractor's requested departure shall be at the expense of Contractor. Contractor shall reimburse Owner for the referenced costs and expenses of Engineer upon demand.
- C. Review of shop drawings by the Engineer will be limited to complete submittals except where review of a partial submittal is specifically requested by the Contractor and where such review of a partial submittal is necessary for timely completion of the Work of the Contract. Where shop drawings of related items are necessary for review of a particular submittal, the Engineer will so inform the Contractor, who will promptly submit such shop drawing of said related items.
- D. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:
 - 1. "Reviewed," if no change or rejection is made. All but four copies of the submitted data will be returned.

2. "Reviewed and Noted," if minor changes or additions are made but resubmittal is not considered necessary. All but four copies of the submitted data will be returned and all copies will bear the corrective marks.
 3. "Resubmit," if the changes requested are extensive or if retransmittal of the submittal to another Contractor, after correction, is required. In this case, the Contractor shall resubmit the items after correction, and the same number of copies shall be included in the resubmittal as in the first submittal. One copy of the first submittal will be retained by the Engineer and two copies will be returned to the Contractor.
 4. "Rejected," if it is considered that the data submitted cannot, with reasonable revision, meet the requirements of the Contract Drawings and Specifications.
- E. Informational Submittals will be reviewed by the Engineer and will be forwarded on to the appropriate party if it complies with requirements. If it does not comply with requirements, the submittal will be returned for re-submittal.
- F. After their use has received approval from the Engineer, partial submittals prepared for a portion of the Work will be reviewed.
- G. Incomplete submittals are not acceptable and will be returned without review.
- H. Any submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION

SECTION 01 41 06

SPECIAL INSPECTIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope
 - 1. The Contractor shall coordinate and schedule the inspections and tests required by the Statement of Special Inspections and cooperate with the Coordinating Special Inspector and Testing/Inspections Agency employed by Owner.
 - 2. Testing and inspections required are indicated in governing codes and the Statement of Special Inspections, included with this Section as Supplement A.

1.2 DEFINITIONS

- A. Building Official: Officer or other designated authority having jurisdiction charged with the administration and enforcement of the governing code.
- B. Coordinating Special Inspector: Certified special inspector responsible for coordinating and verifying the inspection and testing required by the Statement of Special Inspections and reporting to the Building Official and Engineer.
- C. Continuous Special Inspection: The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.
- D. Periodic Special Inspection: The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being or has been performed and at the completion of the work.
- E. Registered Design Professional (RDP): The Professional Engineer whose seal appears on the Contract Documents and Statement of Special Inspections.
- F. Statement of Special Inspection (SSI): A document prepared by the Registered Design Professional and filed with the Building Official that includes the Schedule of Special Inspections listing the materials and work requiring Special Inspection. This document includes the inspection and or verifications required for the project and minimum qualifications for Testing/Inspection Agencies that will be engaged to perform these services.
- G. Special Inspections: Testing and inspection required by governing codes and as indicated in Supplement A, Statement of Special inspections, of this Section.
- H. Testing/Inspection Agency: An agency with experience and capability to conduct testing and inspect indicated Work that specializes in types of test and inspections to be performed.

1.3 QUALITY ASSURANCE

- A. The Owner will employ and pay for services of the Coordinating Special Inspector and Testing/Inspections Agency, who will have a minimum of five years of experience in managing, monitoring, and inspecting building construction.
- B. Special inspections shall be in accordance with applicable building codes and Supplement A, Statement of Special inspections, of this Section.
- C. The Building Official and Coordinating Special Inspector shall be provided with qualifications for all special inspectors and Testing/Inspection Agencies engaged. Special inspectors and testing agencies shall be approved by the Building Official and Coordinating Special Inspector prior to performing work on Site.
- D. Special inspectors and testing agencies shall be qualified in their assigned Special Inspection in accordance with Supplement A, Statement of Special inspections, of this Section.

1.4 SUBMITTALS

- A. Submit the following:
 - 1. The special inspectors and Testing/Inspection Agencies shall submit to the Coordinating Special Inspector and Building Official for review, a copy of their qualifications which shall include the names and qualifications of each of the individual inspectors and technicians who will be performing inspection or tests.
 - 2. The special inspectors and Testing/Inspection Agencies shall disclose potential conflicts of interest with the Contractor or any of the Subcontractors whose work will be inspected or tested.
 - 3. The special inspectors and Testing/Inspection Agencies shall submit interim and final reports of special inspection and testing work in a timely manner in accordance with this specification.
 - 4. The Contractor shall submit manufacturer and fabricator certifications and related documentation specified in this Section or requested by the Coordinating Special Inspector.
 - 5. Representative Samples of materials shall be submitted, when required by Coordinating Special Inspector or Engineer.

1.5 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall review the Statement of Special Inspections, shall coordinate and schedule the inspections and or tests of the work. The Contractor shall notify the special inspector and Testing/Inspection Agency, and the Coordinating Special Inspector, at least 72 hours in advance of the required inspection and at least 24 hours in advance of a required or test.
 - 1. Do not cover the Work to be inspected until inspection has been completed and accepted.
 - 2. Uninspected work that is required to be inspected may be rejected solely on that basis.
- B. The Contractor shall cooperate with the Coordinating Special Inspector so that the Special Inspections and testing are performed without delay or hindrance.

- C. The Contractor shall keep at the project site the latest set of Construction Drawings, field sketches, information bulletins issued by the Engineer, accepted shop drawings, accepted product data sheets, and latest project specifications for use by the Coordinating Special Inspector and Building Official.
- D. The Contractor shall provide incidental labor and facilities; to provide OSHA compliant access to the work to be inspected or tested, to prepare, obtain and handle samples at the site or at the source of products to be tested, and to store and cure test samples.
- E. The performance of this special inspection program shall in no way relieve the Contractor of the obligation to perform the work in accordance with the requirements of the Contract Documents or from implementing its own effective quality control program.
- F. The Contractor shall be solely responsible for construction site safety. Continuous or periodic special inspections shall not be considered to be a review of the Contractor's safety program.
- G. Provide access to Suppliers' and Subcontractors' operations as required.
- H. Where the special inspector or the Testing/Inspection Agency notifies the Contractor of work that does not conform to the requirements of the Contract Documents, the Contractor shall correct or replace the non-conforming work in a timely manner. Corrections or replacement shall be performed prior to proceeding with the work of this or other trades that will prevent correction of the non-conforming work or the adequate confirmation that the deficient work has been corrected. Proceeding with further work by the Contractor prior to correcting the deficiency is at the Contractor's sole risk.
- I. Special Inspections required in this Section do not supersede or make unnecessary inspections and tests required under other Specification Sections or standard inspections required by governing codes, Laws and Regulations.
- J. Testing and inspections requested or required by the Contractor and not required by the Contract Documents are the Contractor's sole responsibility.

1.6 COODINATING SPECIAL INSPECTOR'S RESPONSIBILITIES

- A. Coordinating Special Inspector Will:
 - 1. Review qualifications of special inspectors and Testing/Inspection Agencies and their personnel, submitted by Contractor, relative to conformance with Supplement A, Statement of Special Inspections, and in accordance with governing codes, Laws and Regulations.
 - 2. Coordinate with the Contractor to provide names of each special inspector and Testing/Inspection Agency for each Special Inspection required to the Building Official and RDP.
 - 3. Compile and provide interim reports of inspections and material testing to Building Official and RDP.
 - 4. Compile and provide the Final Report of Special Inspections documenting completion of Special Inspections and correction of discrepancies noted in the Special Inspections to the Building Official, RDP, Contractor and Owner. Council of American Structural Engineers (CASE) Form 102-2001 or similar form shall be used for the Final Report of Special Inspections.

1.7 INSPECTOR RESPONSIBILITIES

- A. Perform Special Inspections including sampling, and testing of materials and methods of construction; review and ascertain compliance with the Contract Documents, governing codes, Laws and Regulations.
- B. Special inspectors and Testing/Inspection Agencies shall keep full and accurate records of inspections. Promptly submit two copies each of reports of inspections and tests to the Coordinating Special Inspector and Contractor. Reports shall include:
 - 1. Name of Testing/Inspection Agency
 - 2. Date issued
 - 3. Project title and number
 - 4. Name and signature of inspector
 - 5. Date of inspection or sampling and test
 - 6. Record of temperature and weather
 - 7. Identification of product and Specification Section
 - 8. Locations of specific areas tested or inspected
 - 9. Type of inspection or test
 - 10. Results of inspections and tests, and observations regarding compliance with the Contract Documents, governing codes, Laws and Regulations
 - 11. Prominent identification of work not conforming with Contract Documents
 - 12. Indicate on report when the Contractor was notified of non-conforming work
 - 13. Reference applicable ASTM standards
- C. The special inspector and Testing/Inspection Agency shall submit reports to the Coordinating Special Inspector and Contractor within 7 calendar days of the inspection or test.
- D. The special inspector and Testing/Inspection Agency shall immediately notify the Contractor and Coordinating Special Inspector of any inspections or test results which fail to comply with the requirements of the Contract Documents. Notification of non-conforming work shall occur on the day observations are made and a Site Observed Deficiency/Discrepancy Memo shall be issued to responsible Contractor(s) and Coordinating Special Inspector on that same day. If the discrepancies are not corrected by the Contractor within one week of identifying the discrepancy, or reasonable time period agreed to with the Coordinating Special Inspector, the Coordinating Special Inspector shall notify the Building Official and RDP of the failure to correct the discrepancy.
 - 1. Notification of non-conforming work shall include a minimum of the following information:
 - a. Description of exact location
 - b. Reference to applicable detail(s) on approved plans and/or specifications
 - c. Name and Title of each person notified and method of notification
 - d. Resolution or corrective action when taken
 - 2. The non-conforming work shall be made to conform with the requirements of the Contract Documents prior to proceeding with the work of this or other trades that will prevent correction of the non-conforming work or the adequate confirmation that the deficient work has been corrected. Proceeding with further work by the Contractor prior to correcting the deficiency is at the Contractor's sole risk.
- E. At the completion of the work requiring Special Inspections, each special inspector and Testing/Inspection Agency, including laboratories, shall provide a statement to the

Coordinating Special Inspector that all work was completed in substantial conformance with the Contract Documents and that all appropriate inspections and tests were performed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SUPPLEMENTS

- A. The supplements listed below, following the "End of Section" designation, are part of this Section:
 - 1. Supplement A - Statement of Special Inspections

END OF SECTION

SECTION 01 42 00

REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

- A. Definitions and terminology applicable to all the Contract Documents are included in the General Conditions and Supplementary Conditions.
- B. Terminology used in the Specifications includes:
 - 1. “Indicated” refers to graphic representations, notes, or schedules on the Drawings, or to other paragraphs or schedules in the Specifications and similar locations in the Contract Documents. Terminology such as “shown”, “noted”, “scheduled”, and “specified” are used to help the user locate the reference without limitation on the location.
 - 2. “Installer”, “applicator”, or “erector” is Contractor or another entity engaged by Contractor, either as an employee or Subcontractor, to perform a particular construction activity, including installation, erection, application or similar Work. Installers shall be experienced in the Work that installer is engaged to perform.
 - a. The term “experienced”, when used with the term “installer” means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; being familiar with Laws and Regulations; and having complied with requirements of authorities having jurisdiction, and complying with requirements of the Supplier of the material or equipment being installed.
 - 3. Trades: Use of a term such as “carpentry” does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as “carpenter”, unless otherwise indicated in the Contract Documents or required by Laws or Regulations. Such terminology also does not imply that specified requirements apply exclusively to trade personnel of the corresponding generic name.
 - 4. “Assigned specialists” and similar terms: Certain Sections of the Specifications require that specific construction activities be performed by specialists recognized as experts in those operations. Engage said specialists for those activities, and their engagement is a requirement over which Contractor has no option. These requirements do not conflict with enforcement of building codes and other Laws and Regulations. Also, such requirements are not intended to interfere with local trade union jurisdictional settlements and similar conventions. Such assignments shall not relieve Contractor of responsibility for complying with the requirements of the Contract Documents.

1.2 APPLICABLE CODES

- A. References in the Contract Documents to code(s) shall mean the following:
 - 1. Recommended Standards for Wastewater Facilities – Ten State Standards
 - 2. NFPA 820 – Fire Protection in Wastewater Treatment and Collection Facilities
 - 3. NFPA 70, NEC 2011 – National Electrical Code
 - 4. NFPA 72 – National Fire Alarm Code
 - 5. NFPA 101 - Life Safety Code

6. Ohio Building Code (2011 Edition with Amendments)
7. Ohio Plumbing Code (2011 Edition with Amendments)
8. Ohio Mechanical Code (2011 Edition with Amendments)
9. Ohio Boiler Rules (2013 Edition with Amendments)
10. International Energy Conservation Code (2009 Edition)
11. International Fuel Gas Code (2009 Edition)
12. International Existing Building Code (2009 Edition)
13. American Society of Civil Engineers, "Minimum Design Loads for Building and Other Structures" (ASCE/SEI 7-05)

1.3 ABBREVIATIONS

- A. Common abbreviations that may be found in the Contract Documents are listed below, alphabetically by their written-out meaning:

alternating current	a-c
ampere	A
Architectural Barriers Act	ABA
Americans with Disabilities Act	ADA
Americans with Disabilities Act Accessibility Guidelines	ADAAG
ante meridian	a.m.
average	avg
biochemical oxygen demand	BOD
brake horsepower	bhp
British thermal unit	Btu
Centigrade (or Celsius)	C
chlorinated polyvinyl chloride	CPVC
chlorofluorocarbons	CFC
Code of Federal Regulations	CFR
cubic inch	cu in
cubic foot	cu ft
cubic yard	cu yd, or CY
cubic feet per minute	cfm
cubic feet per second	cfs
decibel	db
degree Centigrade (or Celsius) (Write)	degrees C or oC
degrees Fahrenheit	degrees F or oF
diameter	dia

direct current	d-c
dollars	\$
each	ea
efficiency	eff
Fahrenheit	F
feet	ft
feet per hour	fph
feet per minute	fpm
feet per second	fps
figure	Fig
flange	flg
foot-pound	ft-lb
gallon	gal
gallons per hour	gph
gallons per minute	gpm
gallons per second	gps
gram	g
grams per liter	g/L
Hertz	Hz
horsepower	hp or HP
hour	hr
human-machine interface	HMI
inch	in.
inches water gage	in. w.g.
inch-pound	in.-lb
inside diameter	ID
iron pipe size	IPS
thousand pounds	kips
thousand pounds per square inch	ksi
kilovolt-ampere	kva
kilowatt	kw
kilowatt-hour	kwhr or kwh
linear foot	lin ft or LF
liter	L
Leadership in Energy and Environmental Design (USGBC)	LEED

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maximum	max
mercury	Hg
milligram	mg
milligrams per liter	mg/l or mg/L
milliliter	ml
millimeter	mm
million gallons per day	mgd or MGD
million gallon	MG
minimum	min
national pipe threads	NPT
net positive suction head	NPSH
net positive suction head available	NPSHA
net positive suction head required	NPSHR
nitrogen oxide (total concentration of mono-nitrogen oxides such as nitric oxide (NO) and nitrogen dioxide (NO ₂))	NO _x
nominal pipe size	NPS
number	no.
operator interface terminal	OIT
ounce	oz
ounce-force	ozf
outside diameter	OD
parts per hundred	pph
parts per million	ppm
parts per billion	ppb
polyvinyl chloride	PVC
post meridian	p.m.
pound	lb
pounds per square inch	psi
pounds per square inch absolute	psia
pounds per square inch gauge	psig
pounds per square foot	psf
process control system	PCS
programmable logic controller	PLC
revolutions per minute	rpm
second	sec
specific gravity	sp gr, or SG

square	sq
square foot	sq ft, or sf
square inch	sq in.
square yard	sq yd, or SY
standard	std
standard cubic feet per minute	scfm
total dynamic head	TDH
totally-enclosed fan-cooled	TEFC
volt	V
volts alternating current	vac
volts direct current	vdc
volatile organic compounds	VOC

1.4 REFERENCES STANDARDS

- A. Refer to Article 3 of the General Conditions, as may be modified by the Supplementary Conditions, relative to reference standards and resolving discrepancies between reference standards and the Contract Documents. Provisions of reference standards are in effect in accordance with the Specifications.
- B. Copies of Standards: Each entity engaged in the Work shall be familiar with reference standards applicable to its construction activity. Copies of applicable reference standards are not bound with the Contract Documents. Where reference standards are needed for a construction activity, obtain copies of standards from the publication source.
- C. Abbreviations and Names: Where reference standards, specifications, codes, manuals, Laws or Regulations, or other published data of international, national, regional or local organizations are referred to in the Contract Documents, the organization issuing the standard may be referred to by their acronym or abbreviation only. Following acronyms or abbreviations that may appear in the Contract Documents shall have the meanings indicated below. Listing is alphabetical by acronym.

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ACS	American Chemical Society
ADSC- IAFD	International Association of Foundation Drilling.

AEIC	Association of Edison Illuminating Companies
AF&PA	American Forest and Paper Association
ABMA	American Bearing Manufacturers Association (formerly Anti-Friction Bearing Manufacturers Association (AFBMA))
AGMA	American Gear Manufacturers Association
AI	Asphalt Institute
AIA	American Institute of Architects
AIChE	American Institute of Chemical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALSC	American Lumber Standards Committee
AMA	Acoustical Materials Association
AMCA	Air Movement and Control Association
AMP	National Association of Architectural Metal Manufacturers, Architectural Metal Products Division
ANSI	American National Standards Institute
APA	The Engineered Wood Association
API	American Petroleum Institute
APHA	American Public Health Association
AREA	American Railway Engineering Association
ARI	Air Conditioning and Refrigeration Institute
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASQ	American Society for Quality
ASSE	American Society of Safety Engineers
ASTM	American Society for Testing and Materials
AWCI	Association of the Wall and Ceiling Industry

AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BAAQMD	Bay Area Air Quality Management District
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association
CBMA	Certified Ballast Manufacturers Association
CDA	Copper Development Association
CEMA	Conveyor Equipment Manufacturers Association
CGA	Compressed Gas Association
CISCA	Ceilings and Interior Systems Construction Association
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
CMAA	Crane Manufacturers Association of America
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
DIN	Deutsches Institut für Normung eV (German Institute for Standardization)
DIPRA	Ductile Iron Pipe Research Association
EJCDC	Engineers Joint Contract Documents Committee
EJMA	Expansion Joint Manufacturers Association, Inc.
ETL	Intertek Testing Services, Inc. (formerly ETL Testing Laboratories, Inc.)
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FM	Factory Mutual (FM Global)
FRPI	Fiberglass Reinforced Plastics Institute
FS	Federal Specification

GA	Gypsum Association
GANA	Glass Association of North America
HEW	United States Department of Health, Education and Welfare
HI	Hydraulic Institute
HMI	Hoist Manufacturers Institute
HUD	United States Department of Housing and Urban Development
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFI	Industrial Fasteners Institute
IRI	Industrial Risk Insurers
ISA	International Society of Automation (formerly Instrument Society of America)
ISO	Insurance Services Office
ISO	International Organization for Standardization
LPI	Lightning Protection Institute
MIA	Marble Institute of America
ML/SFA	Metal Lath/Steel Framing Association
MS	Military Specifications
MSS	Manufacturers' Standardization Society
MMA	Monorail Manufacturers Association
NAAMM	National Association of Architectural Metal Manufacturers
NACE	National Association of Corrosion Engineers
NAPF	National Association of Pipe Fabricators, Inc.
NARUC	National Association of Regulatory Utilities Commissioners
NBHA	National Builders Hardware Association
NCMA	National Concrete Masonry Association
NEC	National Electric Code
NELMA	Northeastern Lumber Manufacturers' Association
NEMA	National Electrical Manufacturers Association

NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NGA	National Glass Association
NHLA	National Hardwood Lumber Association
NHPMA	Northern Hardwood and Pine Manufacturers Association
NIST	United States Department of Commerce, National Institute of Standards and Technology
NLGA	National Lumber Grades Authority
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSF	National Sanitation Foundation
NSSGA	National Stone, Sand, and Gravel Association
NTMA	National Terrazzo and Mosaic Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PEI	Porcelain Enamel Institute
PFI	Pipe Fabrication Institute
PPI	Plastics Pipe Institute
PGMC	Primary Glass Manufacturers Council
PS	Product Standards Section, United States Department of Commerce
RCSC	Research Council on Structural Connections (part of AISC)
RMA	Rubber Manufacturers Association
SAE	Society of Automotive Engineers
SCAQMD	Southern California Air Quality Management District
SCPRF	Structural Clay Products Research Foundation
SCTE	Society of Cable Telecommunications Engineers
SDI	Steel Deck Institute
SDI	Steel Door Institute

SIGMA	Sealed Insulating Glass Manufacturing Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SPI	Society of the Plastics Industry
SPIB	Southern Pine Inspection Bureau
SSPC	Society for Protective Coatings
SWI	Steel Window Institute
TEMA	Tubular Exchanger Manufacturers Association
TCNA	Tile Council of North America
UL	Underwriters Laboratories, Inc.
USAB	United States Access Board
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USGBC	United States Green Building Council
USGS	United States Geological Survey
USPHS	United States Public Health Service
WCLIB	West Coast Lumber Inspection Bureau
WCMA	Window Covering Manufacturers Association
WCMA	Wood Component Manufacturers Association
WDMA	Window and Door Manufacturers Association
WWEMA	Water and Wastewater Equipment Manufacturers Association
WWPA	Western Wood Products Association

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 00
QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve the Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit the Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for the Contractor to provide quality-assurance and -control services required by the Engineer, Owner, Construction Manager, or other authorities having jurisdiction are not limited by provisions of this Section.

1.2 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by the Engineer.
- C. Mockups: Full size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
- D. Preconstruction Testing: Tests and inspections performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.

- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by the Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade or trades.
- J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.3 CONFLICTING REQUIREMENTS

- A. Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to the Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Engineer for a decision before proceeding.

1.4 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Contractor's Quality-Control Manager Qualifications: For supervisory personnel.
- C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Unique characteristics of each quality-control service.

1.5 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. General: Submit quality-control plan within 10 days following Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to the Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out the Contractor's quality-assurance and quality-control responsibilities. Coordinate with the Contractor's construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for the Project.
 - 1. Project quality-control manager may also serve as the Project superintendent.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of the submittal process. Indicate qualifications of personnel responsible for the submittal review.
- D. Testing and Inspection: Include in the quality-control plan a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
 - 2. Owner-performed tests and inspections indicated in the Contract Documents.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by the Contract requirements.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work the Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.6 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Complete test or inspection data.
 - 8. Test and inspection results and an interpretation of test results.
 - 9. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 - 10. Comments or professional opinion on whether tested or inspected Work complies with

the Contract Document requirements.

11. Name and signature of laboratory inspector.
 12. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at the Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether the observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.7 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of the manufacturer who is trained and approved by the manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of the manufacturer who is trained and approved by the manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies and mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for the Project.
 - e. When testing is complete, remove test specimens, assemblies, and mockups. Do not reuse products on the Project.
 - 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to the Engineer, through the Construction Manager, with copy to the Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in location and of size indicated or, if not indicated, as directed by the Engineer.
 2. Notify the Engineer seven days in advance of dates and times when mockups will be constructed.
 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at the Project.
 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 5. Obtain the Engineer's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 7. Demolish and remove mockups when directed, unless otherwise indicated.

1.8 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish the Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 2. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to the Contractor.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to the Owner are the Contractor's responsibility. Contractor shall perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
1. Unless otherwise indicated, Contractor shall provide quality-control services specified and those required by authorities having jurisdiction. Contractor shall perform quality-control services required by authorities having jurisdiction, whether specified or not.
 2. Where services are indicated as the Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by the Owner, unless agreed to in writing by the Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality-control services are indicated as the Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspecting requested by the Contractor and not required by the Contract Documents are the Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

- C. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."
- D. **Manufacturer's Technical Services:** Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. **Retesting/Re-inspecting:** Regardless of whether original tests or inspections were the Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- F. **Testing Agency Responsibilities:** Cooperate with the Engineer, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify the Engineer, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 - 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through the Contractor.
 - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform any duties of the Contractor.
- G. **Associated Services:** Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. **Coordination:** Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and

replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of the Contractor's quality-control plan. Coordinate and submit concurrently with the Contractor's construction schedule. Update as the Work progresses.
 1. Distribution: Distribute schedule to the Owner, Engineer, Construction Manager, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Prepare a record of tests and inspections. Include the following:
 1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to the Engineer.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for the Engineer's and Construction Manager's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Division 01 Section "Cutting and Patching."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are the Contractor's responsibility, regardless of the assignment of responsibility for quality-control services

END OF SECTION

SECTION 01 51 00
TEMPORARY UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Contractor shall provide all temporary utilities required for the Project.
 - 1. Make all arrangements with utility service companies for temporary services and obtain required permits and approvals for temporary utilities.
 - 2. Pay all utility service costs, including cost of water, fuel, and other utility services required for the Work. Owner will pay up to \$200,000 annually for electricity, Contractor to cover remaining.
 - a. Continuously maintain adequate utilities for all purposes during the Project, until removal of temporary utilities and temporary facilities. At minimum, provide and maintain temporary utilities through Substantial Completion and removal of temporary field offices and sheds.
 - 3. Should Owner occupy part of the Project prior to Substantial Completion of the entire Work, cost of utilities consumed via temporary utilities serving the portion occupied by Owner will be shared proportionately between Owner and Contractor as mutually agreed to by the parties.
 - 4. Maintain, including cleaning, temporary utilities and continuously provide consumables as required.
 - 5. Temporary utilities and temporary facilities shall be adequate for personnel using the Site and requirements of Project.
 - 6. Provide temporary utilities and temporary facilities in compliance with Laws and Regulations and, when applicable, requirements of utility owners.
- C. Provide the following temporary utilities:
 - 1. Electricity
 - 2. Lighting.
 - 3. Telephone and communications.
 - 4. Heating, ventilating, and temporary enclosures.
 - 5. Water.
 - 6. Sanitary facilities.
 - 7. First-aid facilities.
 - 8. Fire protection.

1.2 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Price unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's personnel, Engineer, Construction Manager, testing agencies, and authorities having jurisdiction.

1.3 REQUIREMENTS FOR TEMPORARY UTILITIES AND TEMPORARY FACILITIES

A. Electrical:

1. Provide temporary electrical service required for the Work, including continuous power for temporary field offices and sheds. Provide temporary outlets with circuit breaker protection and ground fault protection.
2. Where there is more than one Contractor on a project involving structures, it shall be the obligation and responsibility of the General Contractor to provide and maintain temporary facilities for furnishing light and power necessary for operations under the General Contract, and to make all necessary arrangements therefor, including all required connections, ordering the meter, and paying all fees and inspection charges.

B. Lighting:

1. Minimum lighting shall be five foot-candles for open areas and ten foot-candles for stairs and shops. Provide minimum of one, 300-watt lamp every 15 feet in indoor Work areas. Provide night security lighting of five foot-candles, minimum, within 50 feet of all parts of the Site during hours of darkness, controlled by photocell.
2. The General Contractor shall make the temporary light and power facilities available to the Heating and Ventilating Contractor, the Plumbing Contractor and the Electrical Contractor, and any and all subcontractors, for their use in connection with their Contracts, and may charge each Contractor for such service an amount not to exceed a fraction of the cost of the services, as billed by the utility, proportional to the value of the Project. Removal of temporary facilities shall be by the General Contractor. The installation and meters shall remain until need for same by each Contractor has ceased or until completion of the General Contract. Each Contractor shall provide his own services after completion of the General Contract.

C. Telephone and Communications:

1. Provide temporary telephone and communications required for Contractor's operations at the Site and for summoning emergency medical assistance.

D. Heating, Ventilating, and Enclosures:

1. Provide sufficient temporary heating, ventilating, and enclosures to ensure safe working conditions and prevent damage to existing facilities and the Work.
2. Except where otherwise specified, temporary heating shall maintain temperature of the area served between 50 degrees F and maximum design temperature of building or facility and its contents.
3. Maintain temperature of areas occupied by Owner's personnel or electronic equipment, including offices, lunch rooms, locker rooms, toilet rooms, and rooms containing computers, microprocessors, and control equipment, between 65 degrees F and 80 degrees F with relative humidity less than 75 percent.
4. Required temperature range for storage areas and certain elements of the Work, including preparation of materials and surfaces, installation or application, and curing as applicable, shall be in accordance with the Contract Documents for the associated Work and the Supplier's recommended temperature range for storage, application, or installation, as appropriate.
5. Provide temporary ventilation sufficient to prevent accumulation in construction areas and areas occupied by Owner of hazardous and nuisance levels or concentrations of dust and particulates, mist, fumes or vapors, odors, and gases, associated with construction.
6. Provide temporary enclosures and partitions required to maintain required temperature

and humidity.

7. Where there is more than one Contractor on a project involving structures, it shall be the obligation and responsibility of the General Contractor to provide and maintain temporary heat by means of portable electric, oil or gas-fired units. The General Contractor shall provide and pay for all fuel and electricity used in the temporary facilities and shall provide proper smoke pipes or other means to prevent smoke or smudge from marking up walls, ceilings, or other parts of equipment.
8. Should the temporary heating facilities require electric service, the General Contractor shall provide the necessary wiring and power.
9. After their installation and testing by the Heating & Ventilating Contractor, the permanent heating system facilities may be used for temporary heating purposes with concurrence of the Heating & Ventilating Contractor and the Owner. Any temporary wiring or piping required and all power consumed shall be the obligation and responsibility of the General Contractor.
10. If the General Contractor elects to utilize the permanent heating facilities included in the Project for temporary heat, it shall be the responsibility of the General Contractor to guarantee the heating system for a period of one year following final acceptance of the General Contract or Beneficial Occupancy of the General Contract, whichever comes first, regardless of any earlier Beneficial Occupancy or final acceptance of the Heating and Ventilating Contract. It shall be the responsibility of the General Contractor to replace all filters before the final acceptance of the General Contract.
11. It shall be the responsibility of the General Contractor to the Heating and Ventilating Contractor to repair any damage to heating and ventilating equipment suffered as the result of use by the General Contractor.
12. After the buildings are enclosed excepting windows, doors and similar apertures, temporary enclosures for all apertures shall be provided and temperatures in the entire building shall be continuously maintained at not less than 40 degrees Fahrenheit unless specific permission is granted in writing by the Engineer. The General Contractor shall install on each floor, near the center of the building, a suitable, securely fastened, and properly protected thermometer.
13. The Owner will supply all heat after final acceptance of the General Contract or upon Beneficial Occupancy of a structure by the Owner.

E. Water:

1. Provide temporary water facilities including piping, valves, meters if not provided by owner of existing waterline, backflow preventers, pressure regulators, and other appurtenances. Provide freeze-protection as required.
2. Provide water for temporary sanitary facilities, field offices, Site maintenance and cleaning and, when applicable, disinfecting and testing of systems.
3. Continuously maintain adequate water flow and pressure for all purposes during the Project, until removal of temporary water system.
4. Where the public water supply is available and under control of the Owner, water will be furnished to the General Contractor. Such water supply shall be subject at all times to the control and supervision of the superintendent or manager of the water utility, and at a cost determined by the schedule of charges on file at the office of the utility. Prior to making use of any municipal water, permission in writing to use the water for any particular purpose shall be obtained from the superintendent or manager. The cost, if any, of connection to the water supply shall be paid by the General Contractor.

5. Where the public water supply is owned or controlled by a private company, corporation or individual or municipality other than the Owner, the General Contractor shall make such arrangements at its cost for service with the owners thereof as he requires.
 6. The General Contractor shall make the temporary water service available to the Heating and Ventilating Contractor, the Plumbing Contractor and the Electrical Contractor and to any and all subcontractors, for their reasonable use in connection with their Contracts. Removal of temporary facilities shall be the responsibility of the General Contractor. The installation and meters shall remain until need for same by each Contractor has ceased or until completion of the General Contract. Each Contractor shall provide its own services after completion of the General Contract.
- F. Sanitary Facilities:
1. Provide suitably-enclosed chemical or self-contained toilets for Contractor's employees and visitors to the Site. Location of temporary toilets shall be acceptable to Owner.
 2. Provide supply of potable drinking water and related facilities and consumables for all personnel using the Site.
 3. Provide suitable temporary washing facilities for employees and visitors.
 4. Sanitary conveniences in sufficient numbers and convenient locations for the use of all persons employed on the Work, properly screened from public observation, shall be provided, maintained, and removed by the Contractor or by the General Contractor. The contents of the same shall be removed and disposed of in accordance with applicable laws codes and regulations. The Contractor shall rigorously prohibit the committance of nuisances within, on, or about the Work.
 5. The Contractor shall also obey and enforce such other sanitary regulations and orders and shall take such precautions against infectious diseases as may be deemed necessary by the responsible authority.
- G. First-aid Facilities
1. Provide temporary first-aid stations at or immediately adjacent to the Site's major work areas, and inside Contractor's temporary field office. Locations of first-aid stations shall be determined by Contractor's safety representative.
 2. Provide list of emergency telephone numbers at each hardwired telephone at the Site. List shall be in accordance with the list of emergency contact information required in Section entitled "Pre-Construction Conference:
- H. Fire Protection:
1. Provide temporary fire protection, including portable fire extinguishers rated not less than 2A or 5B in accordance with NFPA 10, Portable Fire Extinguishers, for each temporary building and for every 3,000 square feet of floor area under construction.
 2. Comply with NFPA 241, Safeguarding Building Construction, Alteration, and Demolition Operations, and requirements of fire marshals and authorities having jurisdiction at the Site.
- I. Power, Fuel and Water For Testing:
1. The permanent electrical service, or any part thereof, shall not be connected until the tests on wiring and grounding systems have been successfully completed and test data reviewed by the Engineer.
 2. Where tests on equipment require electric power for testing, such power shall be supplied through the permanent electrical service and through the permanent electrical distribution

and control equipment. All power for testing will be provided by the Owner. The use by the Owner of the permanent electrical service, electrical distribution system, and/or control equipment for the purpose of testing shall not constitute acceptance of the Work.

3. Where tests are specified on fuel-burning equipment, or where tests are specified on other equipment, and require simultaneous operation of the fuel burning equipment, all fuel for such tests will be provided by the Owner.
4. Unless otherwise specified, water of acceptable quality for testing shall be furnished by the General Contractor.

1.4 USE OF OWNER'S SYSTEM

- A. Existing Utility Systems: Do not use systems in existing buildings or structures for temporary utilities without OWNER's written permission and mutually acceptable basis agreed upon by the parties for proportionate sharing of costs between OWNER and CONTRACTOR.
- B. Use of Permanent Utility Systems Provided Under the Project:
 1. Permanent electrical, lighting, water, heating, ventilating, and fire protection systems and first-aid facilities may be used to provide temporary utilities and temporary facilities if the following are met:
 - a. Obtain Owner's written permission to use permanent systems.
 - b. Permanent systems to be used for temporary utilities or temporary facilities shall have achieved Substantial Completion, including complete functionality of all controls.
 - c. Contractor shall pay all costs while using permanent system, including operation, maintenance, replacement of consumables, and provide replacement parts.
 2. Do not use the following permanent facilities:
 - a. Telephone and communication facilities.
 - b. Sanitary facilities.

1.5 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for temporary systems may be new or used, but shall be adequate for

purposes intended and shall not create unsafe conditions, and shall comply with Laws and Regulations.

- B. Provide required materials, equipment, and facilities, including piping, wiring, and controls
- C. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- D. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return air grille in system and remove at end of construction and clean HVAC system as required in Section entitled "Closeout Procedures".
- E. Air Filtration Units: HEPA primary and secondary filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Location of Temporary Utilities and Temporary Facilities:
 - 1. Locate temporary systems for proper function and service.
 - 2. Temporary systems shall not interfere with or provide hazards or nuisances to: the Work under this and other contracts, movement of personnel, traffic areas, materials handling, hoisting systems, storage areas, finishes, and work of utility companies.
 - 3. Do not install temporary utilities on the ground, with the exception of temporary extension cords, hoses, and similar systems in place for short durations.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.
- C. Modify and extend temporary systems as required by progress of the Work.

3.2 USE

- A. Maintain temporary systems to provide safe, continuous service as required.
- B. Properly supervise operation of temporary systems:
 - 1. Enforce compliance with Laws and Regulations.
 - 2. Enforce safe practices.
 - 3. Prevent abuse of services.
 - 4. Prevent nuisances and hazards caused by temporary systems and their use.
 - 5. Prevent damage to finishes.

- 6. Ensure that temporary systems and equipment do not interrupt continuous progress of construction.
- C. At end of each work day, check temporary systems and verify that sufficient consumables are available to maintain operation until work is resumed at the Site. Provide additional consumables if the supply on hand is insufficient.

3.3 REMOVAL

- A. Completely remove temporary utilities, facilities, equipment, and materials when no longer required. Repair damage caused by temporary systems and their removal and restore the Site to condition required by the Contract Documents; if restoration of damaged areas is not specified, restore to preconstruction condition.
- B. Where temporary utilities are disconnected from existing utility, provide suitable, watertight or gastight (as applicable) cap or blind flange, as applicable, on service line, in accordance with requirements of utility owner.
- C. When permanent utilities and systems that were used for temporary utilities, upon Substantial Completion replace all consumables such as filters and light bulbs and parts used during the Work.

END OF SECTION

SECTION 01 51 50

ENGINEER'S FIELD OFFICE TRAILER

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes a separate field office trailer for the exclusive use of Engineer and his assistants. All components, supplied under this specification section shall remain the property of the Contractor at Final Completion of the Work.

1.2 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following items shall be submitted:
 - 1. Proposed layout of the trailer
 - 2. Proposed method of furnishing the utilities
 - 3. Proposed Office Equipment
 - 4. Proposed computer and networking equipment

PART 2 - PRODUCTS

2.1 GENERAL

- A. The field office shall be of trailer type conforming to the standards of Mobile Office Manufacturer's Association and National Fire Protection Association as set forth in ANSI A119.1 and NFPA 501B. The trailer shall be a new single-wide trailer, with a minimum of 500 total interior square feet, not less than 10 feet by 50 feet..
- B. The Contractor shall provide adequate conference room area for Engineer/Owner/Contractor progress meetings at a separate location from the Engineer's Field Office Trailer.
- C. Structural, electrical, and mechanical design shall conform to the local Building Code. The trailer shall be set on blocks and skirted with closure panels. A covered entrance stoop with steps and handrails of metal or pressure treated wood shall be provided.
- D. The Contractor shall connect the office facilities to all utilities, including water, sewer, power, phone and high speed internet service, including any initial set-up and equipment costs. The Contractor shall disconnect and reconnect these services if relocation of the office trailer is required during the contract duration. Contractor shall provide any necessary repair and maintenance of these services. The Contractor shall cover the monthly cost of water, sewer, phone, power and internet service.
- E. The field office shall be located as close to the work site as possible without obstructing the Contractor's work area, or normal plant operations. The office shall be separated from the Contractor's office facilities. The office shall be available for the Engineer's use during the entire life of the Contract and shall not be disturbed, moved, or interrupted without the Engineer's approval. The Contractor shall be responsible for removal.
- F. Parking with a minimum of three (3) spaces shall be provided. Parking area shall be adjacent to the office and shall be graded and maintained until completion of the Contract.
- G. The Contractor shall protect the Engineer's office against theft and shall be responsible for all

loss of Engineer's property and personal property of the employees housed therein due to either fire, theft or other causes.

- H. The Contractor's liability insurance shall include coverage for loss or damage to the office contents including office records, supplies, instruments, equipment and personal property of the personnel using the field office.
- I. The field office trailer shall be provided with the following:
 - 1. Partitioned washroom, wardrobe closet and storage closet in the larger room. Obtain prior approval from the Engineer for floor plan. Each room shall have doors with integral locks, keyed alike.
 - 2. Equip washroom with flush toilet, wash basins with two faucets, medicine cabinet, toilet tissue holder, ten gallon capacity automatic electric water heater and paper towel holder(s).
 - 3. Room with folding tables and chairs to seat minimum 10 people. This requirement may be waived if the Contractor provides the necessary space for such meetings in the Contractor's field office.
 - 4. Potable water service to all fixtures, with ample hot and cold running water
 - 5. Ensure freeze-proof operation of water supply and drains
 - 6. Mini blinds and screens for all windows
 - 7. At least two (2) four-foot single tube fluorescent fixtures in each small room and six (6) in the larger room. Provide incandescent fixtures in the washrooms. Provide incandescent architectural desk lamps for each desk in each room. Provide one wall switch for each room.
 - 8. Carpeted floors in all areas except washroom.
 - 9. Provide two duplex convenience outlets in each small rooms and six in the large room.
 - 10. Computer network connections in all rooms (except washroom)
 - 11. Built-in Items
 - a. Full width double desk on each end with two-drawer file cabinets, pencil drawers and overhead shelves.
 - b. Drafting table, minimum 36 inch by 72 inch with double storage below.
 - c. Forced air heat and air-conditioning. Provide thermostatically controlled heaters capable of maintaining 70-degrees (F) when outside temperature is zero degrees (F). The field office shall be equipped with AC capable of maintaining 72 degrees (F) or less with ambient temperature of 100 degrees (F). Provide minimum of two air conditioning units - rated not less than 8,000 BTU/hr each.
 - 12. Movable Items
 - a. Four (4) flat top desks, minimum 60 inch x 30 inch, with filing and storage drawers.
 - b. One (1) rolling plan rack at least 30 inches wide with twelve (12) hanger spaces. Hangers shall also be provided.
 - c. Two (2) sidearm swivel desk chairs.
 - d. Four (4) office chairs.
 - e. One (1) fireproof four-drawer legal size file cabinet with locks. Cabinet shall be 18 inches wide, 52 inches high and 26 inches deep with 1-hour UL rating and

shall be constructed to support hanging folders of either legal or letter size without additional frame. Also include heat resistant storage container suitable for magnetic media (computer backup media).

- f. Two (2) four-drawer legal size file cabinets with locks, each 18 inches wide, 52 inches high and 26 inches deep. Cabinets shall be constructed to support hanging folders of either legal or letter size without additional frames.
- g. Two (2) wall-mounted dry chemical fire extinguishers.
- h. Electric water cooler with bottled water supply having hot and cold spigots, with continuous service during the contract period.
- i. One (1) 18.1 cu. ft. capacity refrigerator with self-defrosting freezer.
- j. One microwave oven with not less than 1.5 cubic foot oven space.
- k. Ten (10) stacking chairs (conference room).
- l. Two (2) folding utility tables with minimum top dimensions of 30 inches by 60 inches.
- m. Four (4) bookcases with 5 shelves, 3 feet long. Flat top movable desk, minimum 44 inch by 30 inch, with filing and storage drawers.
- n. Two large waste baskets

J. Office Equipment

- 1. * One (1) digital color copy machine by Xerox, Cannon or equal, capable of copying 40,000 copies per year. Features shall include copying and scanning 8.5x11 inch format, 11x17 inch format and 8.5x14 inch format, including automatic document feeder, image enlargement/reduction and collating features, with all supplies and services except paper provided during the contract period. Printer and scanner shall be connected to the trailer computer network.
 - 2. * One (1) plain paper facsimile (fax) machine with digital scanning and copying features, including all supplies and services except paper provided during the contract period.
 - 3. * One (1) network ready laser printer similar to the HP LaserJet 1200 Series PCL 6 for fast high quality black and white printing (include print server and any other appurtenances required for network compatibility).
 - 4. * One (1) network ready color printer similar to HP Business Inkjet 1100 Series, capable of printing high quality double-sided color images (include print server and any other appurtenances required for network compatibility).
- * Note to Contractor: Functions of the copier, fax/scanner/copier, laser printer and color inkjet printer may be combined if approved by the Engineer, except that at least two separate machines capable of making copies and printing must be provided for redundancy.

K. Telephone and Communication Service

- 1. Provide two (2) telephone lines with call rollover for the exclusive use of the Engineer.
- 2. Provide one (1) separate telephone line for the exclusive use of the Engineer fax machine.
- 3. The Contractor shall include the set-up and initial equipment costs for high speed internet service from a provider approved by the Engineer. System shall be DSL or cable if available. A connection for internet service shall be provided in every room

except washroom. A router shall be provided and installed which will allow each computer to connect through the computer network.

4. Provide three (3) push-button type telephones (by Lucent Technologies, Inc., or equal) for the exclusive use of the Engineer. Each phone shall include minimum 8 programmable buttons, speakerphone, conference calling, call transfer, volume control, and ringer control and be capable of receiving calls on 3 separate phone lines. A minimum of one phone shall be cordless.
5. Provide one automatic answering and recording machine.

L. Personal Computers

1. The Engineer field office shall be furnished with two (2) personal computers, configured for use on a Local Area Network. A network switch (Intel PRO/1000, Linksys or equal) capable of 10/100/1000 Mbps speed shall be provided. Contractor shall install all cabling (consistent with 1000 Mbps data transfer rate), and provide configuration and maintenance of the network and all network components (including camera card reader). A wireless router shall also be provided. Surge suppression for all devices shall also be provided. No sharing of the network with the Contractor shall be permitted.
2. Personal desktop computers shall be Dell, IBM or equal (Apple is not acceptable, Dell is preferred) with at least the following features:
 - a. Intel Dual Core processor or better
 - b. 2.8 GHz clock speed or better
 - c. 4 GB of RAM
 - d. 512K L2 cache
 - e. 1 TB internal hard drive
 - f. 1000 Mbps LAN card (NIC)
 - g. DVD-RW drive
 - h. Optical mouse
 - i. Serial port
 - j. Parallel ports
 - k. Three USB ports
 - l. 101-key enhanced keyboard
 - m. 19" flat screen color monitor (32-bit)
 - n. External speakers
 - o. Sound card
 - p. 512 MB video card with graphics accelerator
3. One of the computers shall be configured as a workstation/file server with an additional shared 2 TB hard drive, an upgraded processor with a minimum clock speed of 3 GHz. This computer shall also be equipped with an automatic data backup system, including all necessary hardware, software and backup media for the weekly backup of data on the 2 TB shared hard drive. Backup software shall be configured so that unattended backups (without interaction of an operator) are performed between 8 PM and 6 AM.
4. Provide and install the following PC-based software packages (one license per

computer unless otherwise noted below)*:

- a. Microsoft Windows® 7 Professional (or latest version)
- b. Microsoft Office® Home and Business 20013 (or latest version)
 - 1) Including Word, Excel, Outlook, PowerPoint, and OneNote
- c. Microsoft Project (latest version)
- d. Project management software compatible with that used by the Contractor
- e. Computer software for earthwork volume calculations compatible with that being utilized by the Contractor (if applicable)
- f. Latest version of anti-virus, firewall, and spyware software, by McAfee, Norton, or equal.

* Note to Contractor: The personal computer features specified are the minimum system requirements. The Contractor shall determine if the software packages have any additional system requirements beyond those specified, and meet any additional requirements. Contractor shall also confirm that all software is compatible with the installed operating system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The trailer shall be located on an approved site convenient to the work.
 1. The Contractor shall mobilize the field office trailer within 30 days after the Notice to Proceed and the office facilities shall be ready for occupancy a minimum of 10 days prior to starting work in the field.
 2. The office shall be furnished and maintained until the acceptance of the Contract.
 3. Relocate once, if directed, during the period of the Contract.
 4. Upon the completion and acceptance of the Contract, the Contractor shall remove the field office trailer and restore the area in accordance with the Contract Documents.

3.2 MAINTENANCE

- A. The maintenance of the trailer shall include but not be limited to:
 1. Adequate heating and cooling including a continual supply of fuel.
 2. Electric power and lights.
 3. Water supply and sewer service
 4. Telephone service
 5. Internet Service
 6. Computer services including networking
 7. Snow removal and de-icing in winter
 8. Janitorial services not less than weekly
 9. Pest control
 10. Daily trash pickup

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11. Immediate replacement or repair of any items that break or are otherwise rendered inoperable for their intended function.
- B. Should sanitary and potable water services not be available on or near the site, portable facilities shall be provided for the exclusive use of the Engineer (including hand-washing stations if potable water is not available).
 1. When sanitary and potable water becomes available, services shall be provided.

END OF SECTION

SECTION 01 51 60
PROJECT SIGN

PART 1 - GENERAL

1.1 1.1 SUMMARY

- A. This Section includes requirements for providing a project identification sign.
- B. This Section also includes requirements for providing a cast bronze plaque for permanent installation at the WWTP in the Operations Building (or other location designated by Owner) to commemorate the Project.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The specific text and title information shall be in accordance with the attached template(s) and as provided by the Owner/Engineer prior to construction.
- B. The project sign(s) shall be erected within thirty days (30) days following the Notice to Proceed and shall be maintained until completion of the Contract.
- C. Upon completion of the Contract, the Contractor shall remove the sign(s) and they shall become his property.

2.2 MATERIALS AND CONSTRUCTION

- A. General
 - 1. The project sign(s) shall be as illustrated in the attached figure.
 - 2. The Contractor shall obtain the proper wording for the sign(s) from the Owner/Engineer.
 - 3. The project sign(s) shall be constructed as indicated.
 - 4. All fasteners used in the sign(s) shall be rust-proof.
- B. Painting
 - 1. All paint used shall be exterior grade paint, suitable for use on wood.
 - 2. The sign face backgrounds shall consist of a minimum of two coats of white paint.
 - 3. Letter colors shall be as indicated.
 - 4. The back of the sign(s) and all supports, bracing and trim, shall be painted with a minimum of two coats of the same white paint used for the sign face backgrounds.

2.3 CAST-METAL PLAQUE

- A. General: Provide castings free from pits, scale, sand holes, and other defects. Comply with requirements specified for metal, border style, background texture, and finish and in required thickness, size, shape and copy.
- B. Available Manufacturers:
 - 1. Matthews International Corporation; Bronze Division.

2. Metal Arts; Div. of L&H Manufacturing.
3. Approved equal.
- C. Bronze Castings: ASTM B 584, alloy UNS No. C83600 (No. 1 manganese brown).
- D. Border Style: Double-raised line border.
- E. Background Texture: Manufacturer's standard stipple finish.
- F. Mounting: Concealed studs for substrates encountered.
- G. Size: Portrait orientation, rectangular, 2 ft-6 inches wide, 3 ft-6 inches high.
- H. Letters: Helvetica style, 1 inch, $\frac{3}{4}$ inch and $\frac{5}{8}$ inch height dimensions, maximum of 500 letters to include project description, owner names, owner representatives, engineers, architects, construction manager, and prime contractors. Exact copy to be determined during submittal process.
- I. Contractor shall coordinate with Owner on location for plaque installation.
- J. Cast-Bronze Plaque Finishes: Exposed surfaces free from porosity, burrs, and rough spots, with returns finished with fine-grain air blast.
 1. Raised Areas: Hand-tool and buff borders and raised copy to produce manufacturer's standard satin finish.
 2. Background Finish: Dark oxidized.

2.4 PROJECT IDENTIFICATION SIGN SPECIFICATIONS

- a. Size:
 - i. Sign A: 4' x 8' x $\frac{3}{4}$ " (See Attached).
 - ii. Sign B: 1'-3" x 8' (Name of City Officials, Engineer and Contractor{s}).
- b. Materials:
 - i. Face:

Sign A - $\frac{1}{4}$ " tempered Masonite.
Sign B - $\frac{3}{4}$ " or greater shop sanded (exterior) plywood (one side only).
 - ii. Framing:

Sign A - 2" x 4" nominal on four (4) sides and center cross bracing.
Sign B - 2" x 4" center cross bracing only.
 - iii. Supports: 4" x 4" x 12" nominal post.
- c. Assembly:

Sign A - 2" x 4" frame to fit 4' x 8' board with 2" x 4" cross braces.
Sign B - to be mounted directly to the 4" x 4" post, with cross bracing beneath Sign A.
- d. Mounting:

Signs A and B are to be mounted to the 4" x 4" post with a $\frac{3}{8}$ " minimum bolt and nut, four (4) on each side of the sign. Each bolt is to have two (2) washers, one (1) between the sign and the head of the bolt and the other between the post and the nut.

- e. Erection: 4" x 4" posts are to be set 3 to 4 feet deep into concrete 12" in diameter.
- f. Paint: Face: Three (3) coats outdoor enamel (sprayed).
Rear: One (1) coat outdoor enamel (sprayed).
- g. Lettering: Silkscreen enamels.
Lettering sizes and positioning will be as illustrated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The project sign(s) shall be erected in the location designated by the Engineer.
- B. The sign(s) shall be adequately supported and braced and properly positioned and aligned.
- C. Cast-Metal Plaque: Mount plaque using standard fastening methods recommended in writing by manufacturer for type of wall surface indicated.
 - 1. Concealed Mounting: Mount plaque by inserting threaded studs into tapped lugs on back of plaque. Set in predrilled holes filled with quick-setting cement. Coordinate mounting location with Owner.

3.2 MAINTENANCE

- A. The Contractor shall provide any and all patching, painting, lettering and bracing required to maintain the sign(s) in good condition throughout the duration of the Contract.

END OF SECTION



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SECTION 01 52 00

ENVIRONMENTAL REQUIREMENTS FOR CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Prohibited Construction Procedures: Prohibited construction procedures include, but are not limited to:
 - 1. Dumping of soil material into any stream corridor, any wetlands, any surface waters, or unspecified locations including the 100-year floodplain.
 - 2. Indiscriminate, arbitrary, or capricious operation of equipment in any stream corridors, any wetlands, or any water surface.
 - 3. Pumping of silt-laden water from trenches or other excavations into any surface waters, any stream corridors, or any wetlands.
 - 4. Damaging vegetation adjacent to, or outside of, the access road or the right-of-way.
 - 5. Disposal of trees, brush, and other debris in any stream corridors, any wetlands, any surface waters, or at unspecified locations including the 100-year floodplain.
 - 6. Permanent or unspecified alteration of the flow line of the stream.
 - 7. Open burning of all project debris.
- B. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

1.2 SITE CLEARING AND TOPSOIL STRIPPING AND STOCKPILING

- A. Perform clearing to the limits indicated on the Contract Drawings.
- B. After interfering vegetation has been removed, the Contractor shall strip any and all topsoil from the area to be excavated and stockpile it for future use.

1.3 EROSION AND SEDIMENT CONTROL

- A. Erosion control procedures shall be utilized as shown on the Contract Drawings or as directed. Erosion control shall be undertaken prior to site and access clearing.
- B. Allow sediment to settle out of water that interferes with construction before such waters enter any surface waters. Care should be taken not to damage or kill vegetation to remain during, or as a result of, dewatering operations and/or accumulating silt in the discharge area. Additional settling basins/sediment traps/plastic filter fabric shall be constructed and used as required or specified as necessary to protect vegetation and to achieve environmental objectives. Such facilities shall comply with the Stark County Water Management and Sediment Control Regulations, latest edition.
- C. Minimize amount of bare soil exposed at one time.
- D. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.
- E. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
- F. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

- G. Utilize erosion control procedures, including mulching, on site. Furnish erosion control as required and, immediately following (weather permitting), completion of site and access clearing.
- H. Work on this project is subject to the requirements of the Ohio Environmental Protection Agency (OEPA) and Stark County Soil & Water Conservation District (SWCD) requirements including the provisions of the OEPA General Permit for Stormwater Discharges from Construction Activities and the SWCD Earth Disturbance Permit.

1.4 SITE RESTORATION

- A. General: After the completion of grading operations, the area shall be prepared immediately (weather permitting) for restoration of vegetation in all disturbed areas, except pavement areas. Unused topsoil in stockpile(s) shall be left for use by others and shall be temporarily vegetated as directed.
- B. Erosion control measures shall be utilized immediately, and final restoration shall be undertaken as soon as the area is no longer needed for construction, stockpile or access. Excavated stones and boulders too large to be incorporated in backfilling shall be removed from the construction site to a specified location. Excess on-site soil shall be graded or removed, as directed. The temporary access road shall be left in place. Care should be taken to avoid damage to adjacent vegetation.
- C. Vegetation: Whenever the Contractor disturbs private property which has been grassed and is maintained as a lawn, such surface shall be restored in-kind to the satisfaction of the Engineer. Similarly, if formal trees, shrubs or other plantings are disturbed, the Contractor shall make every effort to restore these in-kind.
- D. In areas where shrub growth, that is growth which is completely wild in nature, is disturbed in order to minimize the impact of the construction, the Engineer may order planting of a number of common trees and/or shrubs in cleared portions. Such plantings shall be installed by an approved nursery man.
- E. Seeding: Seed selection for the disturbed areas shall be as specified and approved by the Engineer. Seed mixtures shall be selected that best conform with or are best suited for the particular site conditions.
- F. Seed selection for erosion control shall provide for a quickly-germinating initial growth to prevent erosion and for a secondary growth which will survive without continuing maintenance by the Owner.
- G. Mulching: Mulching shall occur immediately after seeding and in no case more than three days after seeding. Mulching shall be performed as directed by the Engineer.

1.5 PROTECTION OF TREES

- A. Protect trees located beyond clearing limits.
- B. Construction equipment movement in the vicinity of trees to remain shall be kept to a minimum to avoid compaction of the soil around the trunks of the trees. During backfill operations, the Contractor shall avoid excessive tamping of earth around tree roots and trunks and shall apply an approved mulch to the roots during the operation.
- C. Tunnel below trees to remain when the edge of the excavation would fall six feet or closer to trees six-inch and over DBH. The length of the tunnel shall be five feet on each side of the tree trunk. When roots one-inch or larger are encountered, stop open ditching and tunnel. Tunneling shall be by means of jacking, posting, or other approved means.

- D. Contractor shall retain the services of a qualified tree expert to remove, where necessary, branches which interfere with the construction operations, or repair trees having suffered damage by the construction activities.

1.6 DUST CONTROL

- A. Take all necessary measures to control dust resulting from the work.
- B. Provide positive means to prevent air-borne dust from dispersing into atmosphere. This shall include as a minimum, sprinkling and sweeping on paved areas and sprinkling and mulching in unpaved areas. Apply water to control dust at locations and in such quantities and frequencies as required to prevent dust from becoming a nuisance to the surrounding area. Chloride and/or petroleum compounds shall not be used for dust control.
- C. In the event the Contractor does not adequately provide for the control of dust, or should insufficient quantities of dust control agents be placed, and he fails to place additional quantities within four hours of Engineer's direction, the Owner will perform the required work by whatever means deemed expedient and all expenses incurred by Owner will be charged and paid by the Contractor.
- D. Take care in selecting and applying dust control agents so as not to make roadways or walkways slippery, muddy, or hazardous.

1.7 WATER CONTROL

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

1.8 SURFACE WATER CROSSINGS

- A. Protect slopes at surface water crossings or drainage ways by installing riprap, sand bags, sod, jute mesh or excelsior blankets as conditions require.
- B. Use water diversion berms, sodding, jute mesh or excelsior blankets on slopes exceeding 15 percent.

END OF SECTION

SECTION 01 55 19

ACCESS ROADS AND PARKING AREAS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Contractor shall provide temporary construction roads, walks, parking areas, and appurtenances required during the Project for use by Contractor, Owner's operations, other contractors working on the Project, and emergency vehicles. Temporary roads and parking areas shall be designed and maintained by Contractor and be fully usable in all weather conditions.
- B. Use of Existing Access Roads
 - 1. Contractor will be allowed to use Owner's existing roads upon obtaining Owner's written permission.
 - 2. Prevent interference with traffic on existing roads and parking areas. At all times, keep access roads and entrances serving the Site clear and available to Owner, Owner's employees, emergency vehicles, and other contractors. Do not use these areas for parking or storage of materials.
 - 3. Contractor shall indemnify and hold harmless Owner from expenses caused by Contractor's operations over existing roads and parking areas.
 - 4. Schedule deliveries to minimize use of driveways and entrances.

1.2 SITE ACCESS

- A. Contractor shall access the Site shall through the main entrances shown on the contract drawings.

1.3 TEMPORARY ROADS AND PARKING AREAS

- A. Temporary Roads and Parking in Areas Different from Permanent Pavement: Construct temporary roads and parking areas adequate to support loads and to withstand traffic loads during the Project. Locate temporary roads and parking areas as shown.
 - 1. Provide reasonably level, graded, well-drained subgrade of satisfactory soil material, compacted to at least 95 percent of maximum dry density in the upper six inches.
 - 2. Where required to support loads and provide separation between subgrade and subbase materials, provide geotextile or geogrid as required.
 - 3. Provide crushed stone or gravel subbase material at least six inches thick, roller-compacted to a level, smooth, dense surface. Subbase for temporary roads and areas traveled by construction vehicles shall be adequate for loads and traffic they will serve.
 - 4. Provide dust control treatment that is non-polluting and does not contribute to tracking-out onto pavement. Reapply dust control treatment as required.
- B. Temporary Roads and Parking in Same Areas as Permanent Pavement: Construct temporary roads and parking areas adequate to support construction loads and to withstand exposure to traffic during the Project. Locate temporary roads and parking areas in same location as permanent roads and parking areas. Extend temporary roads and parking areas, within construction limits indicated, as required for construction operations:
 - 1. Coordinate elevations of temporary roads and parking areas with permanent roads and

parking areas.

2. Prepare subgrade, subbase, and base for temporary roads and parking areas per appropriate Specification sections in Division 2. Where required by subgrade conditions and construction loads and traffic, provide geotextile or geogrid on compacted subgrade for subbase support and separation of subbase and subgrade materials.
3. Delay installation of final courses of permanent bituminous pavement until road will not be subject to further heavy construction traffic. Repair damage to bituminous base course of pavement before installing permanent top courses.

1.4 TRAFFIC CONTROLS

- A. Provide temporary traffic controls at intersections of temporary roads with permanent access roads at the Site. Provide warning signs on permanent roads, and provide “STOP” signs for traffic on temporary roads at entrances onto permanent pavement.

1.5 CONTRACTOR PARKING

- A. Contractor’s employee vehicles shall be parked in an area specifically designated by the Owner.
- B. Construction vehicles and equipment shall not be parked on permanent roads and parking areas. Contractor shall park construction vehicles and equipment in the designated construction staging areas.

1.6 MAINTENANCE OF ROADS

- A. General:
 1. Contractor shall maintain temporary roads and parking to continuously provide at the Site access for construction vehicles and trucks, Owner vehicles, deliveries for Owner, emergency vehicles, and parking areas for Owner’s personnel.
 2. Public roads shall be passable at all times unless a road closure is allowed in writing by authority having jurisdiction.
 3. When temporary roads and parking without hard surfacing become contaminated with soil and create a nuisance, remove contaminated material and replace with clean aggregate as required.
 4. Provide snow and ice removal for temporary roads and parking areas when construction activities are taking place on site.
- B. Clean paved roads and parking areas over which Contractor’s vehicles travel. Cleaning shall be done a minimum two times per week or more frequently as directed by Engineer, and shall be by mechanical sweeper. Roads to be cleaned include:
 1. Roads within limits of the Project.
 2. Permanent roads at Site from Site entrance to work areas and construction parking and staging areas.
 3. Public roads that require sweeping and cleaning due to Contractor’s operations.
- C. Dust resulting from Contractor’s activities shall be controlled by Contractor to prevent nuisances at Site and nearby areas. Apply water or use other methods subject to Engineer’s acceptance that will minimize airborne dust. Do not use water when water will cause hazardous or objectionable conditions such as ice, mud, ponds, and pollution.
- D. Provide temporary, heavy-duty steel roadway plates to protect existing manholes, handholes,

valve boxes, vaults, and similar buried facilities.

1.7 REMOVALS AND RESTORATION

A. Removals:

1. Remove temporary roads, walks, and parking areas that are not intended for, or acceptable for, integration into permanent pavement. Return areas of temporary roads, walks, and parking to pre-construction condition unless otherwise required by the Contract Documents. Remove temporary gates, fencing, and traffic controls associated with temporary roads and parking areas.
2. Where areas of temporary roads and parking will be permanently landscaped, remove pavement, aggregate, soil and other material that does not comply with requirements for fill or subsoil and landscaping. Remove and properly dispose of materials contaminated with oil, bitumen, and other petrochemical compounds, and other substances that might impair growth of plants and lawns

B. Restoration:

1. Repair or replace paving, curbs, gutters, and sidewalks affected by temporary roads and parking, and restore to required conditions, per authorities having jurisdiction.
2. Restore to pre-construction conditions existing roads, walks, and parking areas damaged by Contractor, subject to approval of owner of roads, walks, and parking areas.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 57 00
TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide and maintain methods, equipment, and temporary construction as required to control environmental conditions at the Site and adjacent areas.
 - 2. Maintain controls until no longer required.
 - 3. Upon completion of the Work, remove temporary controls and restore Site to specified condition; if condition is not specified, restore Site to pre-construction condition.
 - 4. Temporary controls include, but are not limited to, the following:
 - a. Erosion and sediment controls.
 - b. Noise controls.
 - c. Dust control.
 - d. Pest and rodent control.
 - e. Control of water, including storm water runoff.
 - f. Pollution control.

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with applicable provisions and recommendations of the following:
 - 1. SWPPP

1.3 SUBMITTALS

- A. Submit the following:
 - 1. Plan for construction staging and maintenance of the Site relative to erosion and sediment controls. Indicate on a Site plan approximate areas of planned disturbance of soils and soil cover over time during the Project. For areas not indicated in the Contract Documents as being disturbed and that Contractor proposes to disturb, Shop Drawing shall include proposed erosion and sediment control measures for the additional area.
 - 2. Location and details of temporary settlement basin(s), as necessary.

1.4 EROSION AND SEDIMENT CONTROLS

- A. Erosion Control:
 - 1. Plan and execute construction and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
 - 2. Coordinate erosion controls with requirements of this Section.
 - 3. Hold to a minimum the areas of bare soil exposed at one time.

4. Provide temporary control measures such as berms, dikes, and drains.
5. Construct fills and waste areas by selective placement to eliminate surface silts or clays that will erode.
6. Periodically inspect earthwork to detect evidence of the start of erosion; apply corrective measures as required to control erosion. Continue inspections and corrective measures until permanent vegetation has been established

1.5 NOISE CONTROL

- A. Noise Control:
1. Contractor's vehicles and equipment shall minimize noise to greatest degree practicable.
 2. Noise levels shall conform to Laws and Regulations, including OSHA requirements and local ordinances.
 3. Noise levels shall not interfere with the work of Owner or others.

1.6 DUST CONTROL

- A. Control objectionable dust caused by Contractor's operation of vehicles and equipment, clearing, or other actions. To minimize airborne dust, apply water or use other methods subject to acceptance of Engineer and approval of authorities having jurisdiction.

1.7 PEST AND RODENT CONTROL

- A. Pest and Rodent Control – General:
1. Provide rodent and pest control as required to prevent infestation of the Site and storage areas.
 2. Employ methods and use materials that do not adversely affect conditions at the Site or on adjoining properties.

1.8 WATER CONTROL

- A. Water Control:
1. Provide methods to control surface water and water from excavations and structures to prevent damage to the Work, the Site, and adjoining properties.
 2. Control fill, grading, and ditching to direct water away from excavations, pits, tunnels and other construction areas and to direct drainage to proper runoff courses to prevent erosion, damage, or nuisance.
- B. Equipment and Facilities for Water Control: Provide, operate, and maintain equipment and facilities of adequate size to control surface water.
- C. Discharge and Disposal: Dispose of drainage water in manner to prevent flooding, erosion, and other damage to any and all parts of the Site and adjoining areas, and that conforms to Laws and Regulations.

1.9 POLLUTION CONTROL

- A. Pollution Control:
1. Provide methods, means, and facilities required to prevent contamination of soil, water,

- or atmosphere caused by discharge of noxious substances from construction operations.
- 2. Equipment used during construction shall conform to federal, state, and local Laws and Regulations.
- 3. Refer to Section 01 35 44, Environmental Requirements for Construction.
- B. Spills and Contamination:
 - 1. Provide equipment and personnel to perform emergency measures required to contain spillages, and to remove contaminated soils or liquids.
 - 2. Excavate contaminated earth and dispose of off-Site, and replace with suitable compacted fill and topsoil.
- C. Protection of Surface Waters: Implement special measures to prevent harmful substances from entering surface waters. Prevent disposal of wastes, effluents, chemicals, or other such substances in or adjacent to surface waters and open drainage routes, in sanitary sewers, or in storm sewers.
- D. Atmospheric Pollutants:
 - 1. Provide systems for controlling atmospheric pollutants related to the Work.
 - 2. Prevent toxic concentrations of chemicals.
 - 3. Prevent harmful dispersal of pollutants into atmosphere.
- E. Solid Waste:
 - 1. Provide systems for controlling and managing solid waste related to the Work.
 - 2. Prevent solid waste from becoming airborne, and from discharging to surface waters and drainage routes.
 - 3. Properly handle and dispose of solid waste.

1.10 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.11 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. General:
 - 1. Materials utilized for erosion and sediment controls shall be in accordance with the applicable regulatory requirements indicated in Article 1.2 of this Section, unless otherwise shown or indicated in the Contract Documents.

- B. Silt Fencing:
 - 1. Filter Cloth:
 - a. Mirafi Envirofence, or equal.
 - b. Height: Two feet, minimum.
 - c. Securely fasten filter cloth to wire mesh using ties spaced at maximum intervals of two feet on centers at top and mid-height of wire mesh.
 - 2. Wire Mesh: Support filter cloth with wire mesh complying with the following:
 - a. Woven wire mesh, 14-gauge steel wire, maximum mesh size six-inch by six-inch.
 - b. Height: To match filter cloth height.
 - c. Fasten wire mesh to fence supports with wire ties or staples.
 - 3. Fence Support Posts:
 - a. Length: Three feet, minimum.
 - b. Material: Metal or other acceptable material with "U" or "I" cross section, or minimum 1.25-inch by 1.25-inch hardwood.
- C. Straw Bale Dike.
 - 1. Bales shall be firmly-packed, unrotted straw bound firmly with baling wire. Cross-sectional area on the small end of each bale shall be approximately 12 inches by 12 inches or larger.
 - 2. Posts shall comply with requirements for silt fencing support posts, or may be suitable reinforcing steel.
- D. Mulch Materials and Soil Stabilization.
 - 1. Mulch shall be unrotted straw or salt hay.
 - 2. Soil stabilization emulsions, when used, shall be an inert, eco-friendly chemical manufactured for the specific purpose of erosion control and soil stabilization, applied with mulch or stabilization fibers.
 - 3. Wood-fiber or paper-fiber, when used, shall be 100 percent natural and biodegradable.
 - 4. Erosion control mat or netting shall be biodegradable. Acceptable materials include jute, excelsior, straw or coconut fiber, and cotton.
- E. Protection of Storm Water Drainage Inlets and Catch Basins:
 - 1. Inlet Filter Bag::
 - a. Product and Manufacturer: Provide one of the following for each drainage inlet or catch basin to be protected:
 - 1) Silt Sack, by Atlantic Construction Fabrics (ACF) Environmental
 - 2) Or equal.
 - b. Inlet filter bag permeability shall be not less than 40 gallons per square foot of bag area exposed to the flow. Fabric shall be woven polypropylene with double stitching to prevent bursting.
 - c. Inlet filter bags shall fit inside the drainage inlet or catch basin and shall be secured by the structure's grate or by other acceptable means.
 - d. Inlet filter bags shall have means of removing inlet filter bag and the silt and

sediment collected in the bag, without dumping filter bag's contents into the drainage inlet or catch basin.

F. Temporary Settlement Basin:

1. Embankment Material: Comply with requirements for general fill in Division 31 Sections on earthwork, excavation, and fill.
2. Provide outfall structure consisting of overflow weir and discharge pipe, and provide emergency spillway.
3. Overflow Weir and Discharge Pipe: Suitably-sized piping of corrugated metal, high-density polyethylene, or other suitable material. Pipe may be new or used; if used, pipe shall be in good condition.

G. Filter Bag on Dewatering Pump Discharge:

1. Provide filter bag on discharge of each dewatering pump drawing from an excavation. Filter bag is not required on pumps associated with dewatering wells.
2. Products and Manufacturers: Provide one of the following:
 - a. UltraTech Dewatering Bag, by Interstate Products.
 - b. Filter Bag, by US Fabrics.
 - c. Dewatering (Filter) Bag, Indian Valley Industries
 - d. DirtBag, by Atlantic Construction Fabrics (ACF) Environmental
 - e. Or equal.
3. Size filter bags for maximum flow of the pump. Filter bags shall be specifically fabricated for use as a dewatering pump filter bag.
4. Provide sufficient spare filter bags for continuous dewatering operations.

PART 3 - EXECUTION

3.1 NOISE CONTROL

A. Noise Control:

1. Contractor's vehicles and equipment shall minimize noise to greatest degree practicable.
2. Noise levels shall conform to Laws and Regulations, including OSHA requirements and local ordinances.
3. Noise levels shall not interfere with the work of Owner or others.

3.2 DUST CONTROL

- A. Control objectionable dust caused by Contractor's operation of vehicles and equipment, clearing, or other actions. To minimize airborne dust, apply water or use other methods subject to acceptance of Engineer and approval of authorities having jurisdiction.
- B. Contractor shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce on- and off-Site damage, nuisances, and health hazards associated with dust emissions. Control may be achieved by irrigation in which the Site shall be sprinkled with water until the surface is moist. Apply dust controls as frequently as required without creating nuisances such as excessive mud and ponding of water at the Site.
- C. Remove dust from roadways and access roads at maximum intervals of seven days by

mechanical brooming or other method acceptable to Engineer.

3.3 PEST AND RODENT CONTROL

- A. Pest and Rodent Control – General:
 - 1. Provide rodent and pest control as required to prevent infestation of the Site and storage areas.
 - 2. Employ methods and use materials that do not adversely affect conditions at the Site or on adjoining properties.

3.4 WATER CONTROL

- A. Water Control:
 - 1. Provide methods to control surface water and water from excavations and structures to prevent damage to the Work, the Site, and adjoining properties.
 - 2. Control fill, grading, and ditching to direct water away from excavations, pits, tunnels and other construction areas and to direct drainage to proper runoff courses to prevent erosion, damage, or nuisance.
- B. Equipment and Facilities for Water Control: Provide, operate, and maintain equipment and facilities of adequate size to control surface water.
- C. Discharge and Disposal: Dispose of drainage water in manner to prevent flooding, erosion, and other damage to any and all parts of the Site and adjoining areas, and that conforms to Laws and Regulations.

3.5 POLLUTION CONTROL

- A. Pollution Control:
 - 1. Provide methods, means, and facilities required to prevent contamination of soil, water, or atmosphere caused by discharge of noxious substances from construction operations.
 - 2. Equipment used during construction shall conform to federal, state, and local Laws and Regulations.
 - 3. Refer to Section 01 35 44, Environmental Requirements for Construction.
- B. Spills and Contamination:
 - 1. Provide equipment and personnel to perform emergency measures required to contain spillages, and to remove contaminated soils or liquids.
 - 2. Excavate contaminated earth and dispose of off-Site, and replace with suitable compacted fill and topsoil.
- C. Protection of Surface Waters: Implement special measures to prevent harmful substances from entering surface waters. Prevent disposal of wastes, effluents, chemicals, or other such substances in or adjacent to surface waters and open drainage routes, in sanitary sewers, or in storm sewers.
- D. Atmospheric Pollutants:
 - 1. Provide systems for controlling atmospheric pollutants related to the Work.
 - 2. Prevent toxic concentrations of chemicals.

3. Prevent harmful dispersal of pollutants into atmosphere.
- E. Solid Waste:
 1. Provide systems for controlling and managing solid waste related to the Work.
 2. Prevent solid waste from becoming airborne, and from discharging to surface waters and drainage routes.
 3. Properly handle and dispose of solid waste.

3.6 EROSION AND SEDIMENT CONTROLS

- A. General:
 1. Provide erosion and sediment controls as shown and indicated on the Drawings and elsewhere in the Contract Documents. Provide erosion and sediment controls as the Work progresses into previously undisturbed areas.
 2. Installation of erosion and sediment controls shall be in accordance with best management practices (BMP) and any applicable local regulatory requirements, unless otherwise shown or indicated in the Contract Documents.
 3. Plan and execute construction, disturbances of soils and soil cover, and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation. Provide temporary measures for controlling erosion and sedimentation, as indicated in the Contract Documents and as required for the Project.
 4. Where areas must be cleared for storage of materials or equipment, or for temporary facilities, provisions shall be made for regulating drainage and controlling erosion and sedimentation, subject to the Engineer's approval.
- B. Coordination:
1. Coordinate erosion and sediment controls with this Section's requirements on water control and with Stormwater Pollution Prevention Plan and Permit.
- C. Coordinate temporary erosion and sediment controls with construction of permanent drainage facilities and other Work to the extent necessary for economical, effective, and continuous erosion and sediment control.
- D. Before commencing activities that will disturb soil or soil cover at the Site, provide all erosion and sediment control measures required by the Contract Documents for the areas where soil or soil cover will be disturbed.
- E. In general, implement construction procedures associated with, or that may affect, erosion and sediment control to ensure minimum damage to the environment during construction. Contractor shall implement any and all additional measures required to comply with Laws and Regulations, and Stormwater Pollution Prevention Plan and Permit.
- F. Vegetation Removal: Remove only those shrubs, grasses, and other vegetation that must be removed for construction. Protect remaining vegetation.
- G. Access Roads and Parking Areas: When possible, access roads and temporary roads shall be located and constructed to avoid adverse effects on the environment. Provisions shall be made to regulate drainage, avoid erosion and sedimentation, and minimize damage to vegetation.
- H. Earthwork and Temporary Controls:
 1. Perform excavation, fill, and related operations in accordance with Section 31 23 00, Excavation and Fill.

2. Control erosion to minimize transport of silt from the Site into existing waterways and surface waters. Apply such temporary measures to erodible materials exposed by activities associated with the construction of the Project.
 3. Hold to a minimum the areas of bare soil exposed at one time.
 4. Construct fills and waste areas by selectively placing fill and waste materials to eliminate surface silts and clays that will erode.
 5. Contractor shall provide special care in areas with steep slopes, where disturbance of vegetation shall be minimized to maintain soil stability.
- I. Inspection and Maintenance:
1. Periodically inspect areas of earthwork and areas where soil or soil cover are disturbed to detect evidence of the start of erosion and sedimentation.
 2. Inspect not less often than the frequency specified in Stormwater Pollution Prevention Plan and Permit.
 3. Repair or replace damaged erosion and sediment controls within 24 hours of Contractor becoming aware of such damage.
 4. Periodically remove silt and sediment that has accumulated in or behind sediment and erosion controls. Properly dispose of silt and sediment.
- J. Duration of Erosion and Sediment Controls:
1. Maintain erosion and sediment controls in effective working condition until the associated drainage area has been permanently stabilized.
 2. Maintain erosion and sediment controls until the Site is restored and site improvements including landscaping, if any, are complete with underlying soils permanently stabilized.
 3. Work Stoppage: If the Work is temporarily stopped or suspended for any reason, Contractor shall provide additional temporary controls necessary to prevent environmental damage to the Site and adjacent areas while the Work is stopped or suspended.
 4. Failure to Provide Adequate Controls: In the event Contractor repeatedly fails to satisfactorily control erosion and siltation, Owner reserves the right to employ outside assistance or to use Owner's own forces for erosion and sediment control. Cost of such work, plus engineering and inspection costs, will be deducted from monies due Contractor inspect earthwork to detect evidence of the start of erosion; apply corrective measures as required to control erosion. Continue inspections and corrective measures until permanent vegetation has been established.
- K. Silt Fencing:
1. Install and maintain silt fencing in a vertical plane, at the location(s) shown or indicated on the Drawings.
 2. Locations of Silt Fencing:
 - a. Where possible, install silt fencing along contour lines so that each given run fencing is at the same elevation.
 - b. Provide silt fencing around perimeter of each stockpile of topsoil, general fill material, and excavated material. Install silt fencing before expected precipitation and maintain until stockpile is removed.
 - c. Do not install silt fencing at the following types of locations:

- 1) Area of concentrated storm water flows such as ditches, swales, or channels.
 - 2) Where rock or rocky soils prevent full and uniform anchoring of silt fencing.
 - 3) Across upstream or discharge ends of storm water piping or culverts.
3. Installation:
 - a. Securely fasten wire mesh to posts, and securely fasten filter cloth to wire mesh.
 - b. When two sections of filter cloth abut each other, fold over edges and overlap by minimum of six inches and securely fasten to wire mesh.
 - c. Embed posts in the ground to the depth necessary for proper controls; embed posts to at least 16 inches below ground.
 - d. Filter cloth and wire mesh shall extend a minimum of eight inches below ground and a minimum of 16 inches above ground.
 - e. Remove sediment accumulated at silt fencing as required. Repair and reinstall silt fencing as required.
4. Maintenance:
 - a. Do not allow formation of concentrated storm water flows on slopes above silt fencing unless so shown or indicated in the Contract Documents. If unauthorized concentrated storm water flows occur, stabilize the slope via earthmoving and other stabilization measures as required to prevent flow of concentrated storm water flows toward silt fencing.
- L. Straw Bale Dike.
 1. Install straw bale dikes where shown or indicated, including in swales, along contours, and along toe of slopes.
 2. Install bales in shallow excavation as wide as the bale and approximately four to six inches below surrounding grade.
 3. Ends of bale shall tightly abut ends of adjacent bales.
 4. Securely install straw bales using two support posts per bale, driven into the ground a minimum of 1.5 to two feet below bottom of bale. Top of post shall be flush with top of bale. Angle first post for each bale toward the previously-installed bale.
 5. Frequently inspect bales and repair or replace as required. Remove accumulated silt and debris from behind straw bales.
- M. Mulching and Soil Stabilization:
 1. Use mulching to temporarily stabilize exposed soil and fill material.
 - a. Immediately following final grading, provide mulch and stabilize with mats or netting, or sprayed soil stabilization emulsion with fiber additive.
 - b. Application of mulching for soil stabilization shall be as follows.
 - 1) Unrotted Straw or Salt Hay: 1.5 to two tons per acre.
 - 2) Wood-fiber or Paper-fiber Application: 1,500 lbs. per acre, installed by hydroseeding.
 - c. Where mats or netting are used:
 - 1) Cover entire area to be stabilized with mats or netting.
 - 2) Provide anchoring trenches at the top and bottom of slopes to receive mats or netting. Bury at least the top and bottom ends of mat or netting, four

inches or more wide, at top and bottom of slope.

- 3) Overlap adjacent strips of mat or netting by at least four inches.

N. Protection of Storm Water Drainage Inlets and Catch Basins:

1. Protect each drainage inlet and catch basin that has the potential to receive storm water runoff from exposed soils, and does not discharge into a storm water settlement basin.
2. Install inlet filter bags inside of drainage inlet or catch basin in accordance with manufacturer's instructions. Secure inlet filter bag with the structure's grate or by other acceptable means.
3. Inlet filter bags shall not pose any obstruction above the elevation of the drainage inlet or catch basin grate requiring barricades or flashers.
4. Remove silt and sediment from inlet filter bag, or replace inlet filter bag, when inlet filter bag is not more than half full.

O. Temporary Settlement Basin.

1. For constructing embankments comply with requirements in Division 31 Sections on earthwork, embankments, excavation, and fill.
2. Overflow Weir and Discharge Pipe:
 - a. Install piping in accordance with manufacturer's instructions.
 - b. Install overflow weirs at elevations on shown or indicated on the Drawings or approved Shop Drawings, as applicable, to avoid overtopping and overfilling of settlement basin without short-circuiting the settlement basin's hydraulics.
 - c. Wrap geotextile material specified for silt fencing around discharge structures of temporary settlement basins
3. Crushed Stone and Riprap: Install in accordance with Division 31 Sections on crushed stone and riprap. Provide in areas of temporary settlement basin subject to erosion, and at upstream and downstream ends of discharge piping.
4. Remove sediment when required based on accumulation of material.
5. When temporary settlement basin is no longer required, remove the temporary settlement basin discharge weir, discharge pipe, and spillway, fill the temporary sediment basin to required grade in accordance with requirements of Division 31 Section on excavation and fill, and provide landscaping in accordance with Division 32 Sections on landscaping.

P. Filter Bag on Dewatering Pump Discharge:

1. Provide dewatering of excavations in compliance with Division 31 Sections on earthmoving, excavation, and fill.
2. Locate filter bags and temporary pump discharge lines to avoid interfering with the public, use of private property, and Owner's operations. Relocate filter bags and appurtenances when required.
3. Filter bag discharge shall be directed to appropriate storm water drainage route. Do not discharge into roadways, driveways, access roads, and overland. When temporary settlement basin is used, locate filter bags to discharge to temporary settlement basin when practicable.
4. Provide filter bag on discharge of each dewatering pump drawing from an excavation.

5. Securely attach filter bag to pump discharge pipe or hose.
 6. Maintain, clean out, and replace filter bags as required.
- Q. Temporary Stone Construction Entrance:
1. Where shown on the Drawings, and where construction vehicles will regularly transit to paved surfaces from unstabilized surfaces, provide a temporary stone construction entrance. Contractor vehicles shall use temporary construction entrances.
 2. Provide temporary stone construction entrances of the width, length, and thickness shown or indicated on the Drawings. When not shown or indicated on the Drawings, temporary stone construction entrance shall be not less than 50 feet long, by 20 feet wide, by eight inches deep.
 3. Installation:
 - a. Ensure that subgrade under temporary stone construction entrance is suitably dense for the intended purpose. Suitably prepare subgrade as required for temporary construction entrance.
 - b. Provide on subgrade a layer of geotextile fabric, installed in accordance with geotextile manufacturer's recommendations for separation.
 - c. Provide stone on installed geotextile.. Grade stone for passage of vehicles.
 4. Maintenance:
 - a. Maintain temporary stone construction entrance at not less than the minimum required thickness. Add stone as required to maintain thickness.
 - b. When upper layer of temporary stone construction entrance becomes contaminated with soil, remove the contaminated material and replace with clean stone.
 - c. Using water to wash down temporary construction entrance or paved areas onto which soil material has been tracked is not allowed

3.7 REMOVAL OF TEMPORARY CONTROLS

- A. General:
1. Upon completion of the Work, remove temporary controls and restore Site to specified condition; if condition is not specified, restore Site to pre-construction condition.
 2. After soils are permanently stabilized, remove from the Site temporary erosion and sediment controls

END OF SECTION

SECTION 01 66 00

PRODUCT DELIVERY, STORAGE AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section includes general requirements for delivering, storing and protecting materials and equipment.

1.2 GENERAL

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

1.3 DELIVERY AND HANDLING

- A. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
- B. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
- C. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
- D. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

1.4 STORAGE

- A. Store and protect materials and equipment in accordance with manufacturer's recommendations and the Contract Documents.
- B. Contractor shall make all arrangements and provisions necessary for, and pay all costs for, storing materials and equipment. Excavated materials, construction equipment, and materials and equipment to be incorporated into the Work shall be placed to avoid injuring the Work and existing facilities and property, and so that free access is maintained at all times to all parts of the Work and to public utility installations in vicinity of the Work. Store materials and equipment neatly and compactly in locations that cause minimum inconvenience to Owner, other contractors, public travel, and owners, tenants, and occupants of adjoining property. Arrange storage in manner to allow easy access for inspection.
- C. Areas available at the Site for storing materials and equipment are shown or indicated in the Contract Documents, or as approved by Engineer.
- D. Store materials and equipment to become Owner's property to facilitate their inspection and ensure preservation of quality and fitness of the Work, including proper protection against damage by freezing, moisture, and high temperatures with ambient temperatures as high as (105) degrees F. Store in indoor, climate-controlled storage areas all materials and equipment subject to damage by moisture, humidity, heat, cold, and other elements, unless otherwise acceptable to Owner. When placing orders to Suppliers for equipment and controls containing computer chips, electronics, and solid-state devices, Contractor shall obtain, coordinate, and comply with specific temperature and humidity limitations on materials and equipment, because

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temperature inside cabinets and components stored in warm temperatures can approach 200 degrees F.

- E. Contractor shall be fully responsible for loss or damage (including theft) to stored materials and equipment.
- F. Do not open manufacturer's containers until time of installation, unless recommended by the manufacturer or otherwise specified in the Contract Documents.
- G. Do not store materials or equipment in structures being constructed unless approved by Engineer in writing.
- H. Do not use lawns or other private property for storage without written permission of the owner or other person in possession or control of such premises.

1.5 PROTECTION

- A. Equipment to be incorporated into the Work shall be boxed, crated, or otherwise completely enclosed and protected during shipping, handling, and storage.
- B. Store all materials and equipment off the ground (or floor) on raised supports such as skids or pallets.
- C. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Painted equipment surfaces that are damaged or marred shall be repainted in their entirety in accordance with equipment manufacturer and paint manufacturer requirements, to the satisfaction of Engineer.
- D. Protect electrical equipment, controls, and instrumentation against moisture, water damage, heat, cold, and dust. Space heaters provided in equipment shall be connected and operating at all times until equipment is placed in operation and permanently connected.

1.6 UNCOVERED STORAGE

- A. The following types of materials may be stored outdoors without cover on supports so there is no contact with the ground:
 - 1. Reinforcing steel.
 - 2. Precast concrete materials.
 - 3. Structural steel.
 - 4. Metal stairs.
 - 5. Handrails and railings.
 - 6. Grating.
 - 7. Checker plate.
 - 8. Metal access hatches.
 - 9. Castings.
 - 10. Fiberglass products.
 - 11. Rigid electrical conduit.
 - 12. Piping, except polyvinyl chloride (PVC) or chlorinated PVC (CPVC) pipe.

1.7 COVERED STORAGE

- A. The following materials and equipment may be stored outdoors on supports and completely covered with covering impervious to water:
 - 1. Grout and mortar materials.
 - 2. Masonry units.
 - 3. Rough lumber.
 - 4. Soil materials and granular materials such as aggregate.
 - 5. PVC and CPVC pipe.
 - 6. Filter media.
- B. Tie down covers with rope, and slope covering to prevent accumulation of water.
- C. Store loose granular materials, with covering impervious to water, in well-drained area or on solid surfaces to prevent mixing with foreign matter.

1.8 FULLY PROTECTED STORAGE

- A. Store all material and equipment not named in Articles 1.4 and 1.5 of this Section on supports in buildings or trailers that have concrete or wooden flooring, roof, and fully closed walls on all sides. Covering with visquine plastic sheeting or similar material in space without floor, roof, and walls is not acceptable. Comply with the following:
 - 1. Provide heated storage for materials and equipment that could be damaged by low temperatures or freezing.
 - 2. Provide air-conditioned storage for materials and equipment that could be damaged by high temperatures.
 - 3. Protect mechanical and electrical equipment from being contaminated by dust, dirt, and moisture.
 - 4. Maintain humidity at levels recommended by manufacturers for electrical and electronic equipment.

1.9 HAZARDOUS PRODUCTS

- A. Prevent contamination of personnel, storage area, and the Site. Comply with Laws and Regulations, manufacturer's instructions.

1.10 MAINTENANCE OF STORAGE

- A. On scheduled basis, periodically inspect stored materials and equipment to ensure that:
 - 1. Condition and status of storage facilities is adequate to provide required storage conditions.
 - 2. Required environmental conditions are maintained on continuing basis.
 - 3. Materials and equipment exposed to elements are not adversely affected.
- B. Mechanical and electrical equipment requiring long-term storage shall have complete manufacturer's instructions for servicing each item, with notice of enclosed instructions shown on exterior of container or package.
 - 1. Comply with manufacturer's instructions on scheduled basis.
 - 2. Space heaters that are part of electrical equipment shall be connected and operated continuously until equipment is placed in service and permanently connected.

1.11 MICROPROCESSORS, PANELS, AND INSTRUMENTATION STORAGE

- A. Store panels, microprocessor-based equipment, electronics, and other devices subject to damage or decreased useful life because of temperatures below 40 degrees F or above 100 degrees F, relative humidity above 90 percent, or exposure to rain or exposure to blowing dust in climate-controlled storage space.
- B. Requirements:
 - 1. Storage shall be in third-party owned, bonded, insured, climate-controlled warehouse in the City of Massillon, or respective County.
 - 2. Owner and Engineer have the right to inspect materials and equipment during normal working hours.
 - 3. Placed inside each panel or device a desiccant, volatile corrosion inhibitor blocks (VCI), moisture indicator, and maximum-minimum indicating thermometer.
 - 4. Check panels and equipment at least once per month. Replace desiccant, VCI, and moisture indicator as often as required, or every six months, whichever occurs first.
 - 5. Certified record of daily maximum and minimum temperature and humidity in storage facility shall be available for inspection by Owner and Engineer. Certified record of monthly inspection, noting maximum and minimum temperature for month, condition of desiccant, VCI, and moisture indicator, shall be available for inspection by Owner and Engineer.
- C. Costs for storing climate-sensitive materials and equipment shall be paid by Contractor. Replace panels and devices damaged during storage, or for which storage temperatures or humidity range has been exceeded, at no additional cost to Owner. Delays resulting from such replacement are causes within Contractor's control.
- D. Do not ship panels and equipment to the Site until conditions at the Site are suitable for installation, including slabs and floors, walls, roofs, and environmental controls. Failure to have the Site ready for installation shall not relieve Contractor from complying with the Contract Documents.

1.12 RECORDS

- A. Keep up-to-date account of materials and equipment in storage to facilitate preparation of Applications for Payment, if the Contract Documents provide for payment for materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 71 23
FIELD ENGINEERING

GENERAL

1.1 DESCRIPTION

- A. Contractor shall provide field engineering services and professional services of the types indicated for the Project, including:
 - 1. Furnishing civil, structural, and other professional engineering services specified or required to execute Contractor's construction methods.
 - 2. Developing and making all detail surveys and measurements required for construction; including slope stakes, batter boards, and all other working lines, elevations, and cut sheets.
 - 3. Providing materials required for benchmarks, control points, batter boards, grade stakes, structure and pipeline elevation stakes, and other items.
 - 4. Keeping a transit or total station; leveling instrument; and related implements such as survey rods and other measurement devices, at the Site at all times, and having a skilled instrument person available when necessary for laying out the Work.
 - 5. Being solely responsible for all locations, dimensions and levels. No data other than Change Order, Work Change Directive, or Field Order shall justify departure from dimensions and levels required by the Contract Documents.
 - 6. Rectifying all Work improperly installed because of not maintaining, not protecting, or removing without authorization established reference points, stakes, marks, and monuments.
 - 7. Providing such facilities and assistance necessary for Engineer to check lines and grade points placed by Contractor. Do not perform excavation or embankment work until all cross-sectioning necessary for determining payment quantities for Unit Price Work have been completed and accepted by Engineer.

1.2 CONTRACTOR'S FIELD ENGINEER

- A. Employ and retain at the Site a field engineer with experience and capability of performing all field engineering tasks required of Contractor, including:
 - 1. Preparing and maintaining daily reports of activity on the Work. Submit reports to Engineer including the following information, at minimum:
 - a. Number of employees at the Site.
 - b. Number employees at the Site for each Subcontractor.
 - c. Breakdown of employees by trades.
 - d. Major equipment and materials installed as part of the Work.
 - e. Major construction equipment utilized.
 - f. Location of areas in which construction was performed.
 - g. Materials and equipment received.
 - h. Work performed, including field quality control measures and testing.
 - i. Weather conditions.

- j. Safety.
- k. Delays encountered, amount of delay incurred, and the reasons for the delay.
- l. Instructions received from Engineer or Owner.
- 2. Submit two (2) copies of Contractor daily reports at Engineer's field office by 9:00 a.m. the next working day after the day covered in the associated report. Daily report shall be signed by responsible member of Contractor's staff, such as Contractor's project manager or superintendent, or foreman designated by Contractor as having authority to sign daily reports.
- 3. Check all formwork, reinforcing, inserts, structural steel, bolts, sleeves, piping, other materials and equipment for compliance with the Contract Documents.
- 4. Maintain field office files and drawings, record documents, and coordinate field engineering services with Subcontractors and Suppliers as appropriate. Prepare layout and coordination drawings for construction operations.
- 5. Check and coordinate the Work for conflicts and interferences, and immediately advise Engineer and Resident Project Representative, if any, of all discrepancies of which Contractor is aware.
- 6. Cooperate as required with Engineer and Resident Project Representative, if any, in observing the Work and performing field inspections.
- 7. Review and coordinate the Work with Shop Drawings and Contractor's other submittals.
- B. Contractor's engineer shall be a registered, professional engineer of discipline required for specific service on the Project, licensed in the same state as the Site.

1.3 CONTRACTOR'S SURVEYOR

- A. Employ or retain the services, as needed, at the Site a surveyor with experience and capability of performing surveying and layout tasks required in the Contract Documents and as required for the Work. Surveyor shall be a professional land surveyor registered and licensed in the jurisdiction where the Project is located, or a professional engineer registered and licensed as a professional engineer in the jurisdiction where the Project is located and authorized under Laws and Regulations to practice surveying. Surveyor's tasks include, but are not necessarily limited to, the following:
 - 1. Providing required surveying equipment, including transit or theodolite, level, stakes, and surveying accessories.
 - 2. Establishing required lines and grades for constructing all facilities, structures, pipelines, and site improvements.
 - 3. Preparing and maintaining professional-quality, accurate, well organized, legible notes of all measurements and calculations made while surveying and laying out the Work.
 - 4. Prior to backfilling operations, survey, locate, and record on a copy of the Contract Documents accurate representation of buried Work and Underground Facilities encountered.
 - 5. Complying with requirements of the Contract Documents relative to surveying and related work.

1.4 SUBMITTALS

- A. Informational Submittals: Submit the following:

1. Field Engineering:
 - a. Submit daily reports as indicated in this Section.
 - b. When requested by Engineer, submit documentation verifying accuracy of field engineering.
2. Surveying:
 - a. Complete plan for conducting survey work, submitted ten days prior to beginning survey Work.
 - b. Example of proposed survey field books to be maintained by Contractor's surveyor.
 - c. Submit original field books within two days after completing survey Work.
 - d. Submit certified survey in accordance with this Section.
3. Certificates: Submit certificate signed by professional engineer or professional surveyor, as applicable, certifying that elevations and locations of THE Work comply with the Contract Documents. Explain all deviations, if any.
4. Qualifications Statements:
 - a. Field Engineer: Name and address. When requested by Engineer, submit qualifications.
 - b. Surveyor: Name and address of firm, and resumes of each professional land surveyor and crew chief conducting the survey Work. Submit at least ten days prior to beginning survey Work. During the Project, submit resume for each new registered land surveyor and crew chief employed by or retained by Contractor at least ten (10) days prior to starting on the survey Work.

1.5 RECORDS

- A. Maintain at the Site a complete and accurate log of control and survey Work as it progresses.
 1. Survey data shall be in accordance with recognized professional surveying standards, Laws and Regulations, and prevailing standards of practice in the locality where the Site is located. Completeness and accuracy of survey Work, and completeness and accuracy of survey records, including field books, shall be responsibility of Contractor.
 2. Illegible notes or data, and erasures on any page of field books, are unacceptable. Do not submit copied notes or data. Corrections by ruling or lining out errors will be unacceptable unless initialed by the surveyor.
- B. Upon completion of foundation walls and major Site improvements, prepare a certified survey, signed and sealed by professional surveyor. The survey shall show all dimensions, locations, angles and elevations of construction and locations and elevations of Underground Facilities encountered during the Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SURVEYING

- A. Reference Points:

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FIELD ENGINEERING

1. Refer the General Conditions, as may be modified by the Supplementary Conditions, regarding reference points.
 2. Owner's established reference points damaged or destroyed by Contractor shall be re-established by Contractor at no expense to Owner.
 3. Establish, place, and replace as required, such additional stakes, markers, and other reference points necessary for control, intermediate checks, and guidance of construction operations.
- B. Construction Surveying: Comply with the following:
1. Alignment Staking: Provide alignment stakes at 25-foot intervals on tangent, and at 10-foot intervals on curves.
 2. Slope Staking: Provide slope staking at 25-foot intervals on tangent, and at 10-foot intervals on curves. Re-stake at every ten-foot difference in elevation.
 3. Structure: Stake out structures, including elevations, and check prior to and during construction.
 4. Pipelines: Stake out pipelines including elevations, and check prior to and during construction.
 5. Road: Stake out roadway elevations at 25-foot intervals on tangent, and at 15-foot intervals on curves.
 6. Cross-sections: Provide original, intermediate, and final staking as required, for site work other locations as necessary for quantity surveys.
 7. Easement Staking: Provide easement staking at 25-foot intervals on tangent, and at 15-foot intervals on curves. Also provide wooden laths with flagging at 50-foot maximum intervals.
 8. Record Staking: Provide permanent stake at each blind flange and each utility cap is provided for future connections. Stakes for record staking shall be material acceptable to Engineer.
- C. Accuracy:
1. Establish Contractor's temporary survey references points for Contractor's use to at least second-order accuracy (e.g., 1:10000). Construction staking used as a guide for the Work shall be set at least third-order accuracy (e.g., 1:5000). Basis on which such orders are established shall provide the absolute margin for error specified below.
 2. Horizontal accuracy of easement staking shall be plus or minus 0.1 feet. Accuracy of other staking shall be plus or minus 0.04 feet horizontally and plus or minus 0.02 feet vertically.
 3. Survey calculations shall include an error analysis sufficient to demonstrate required accuracy.

END OF SECTION

SECTION 01 73 29
CUTTING AND PATCHING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Contractor shall perform cutting, coring, rough patching and finish patching of holes and openings in existing construction.
- B. Provide cutting, coring, fitting and patching, including attendant excavation and backfill, required to complete the Work, and to:
 - 1. Remove and replace defective Work;
 - 2. Remove construction as indicated in the Contract Documents or as required to complete the Work in the Contract Documents;
 - 3. Uncover Work for Engineer's and Owner's inspection and/or observation;
 - 4. Connect to completed Work not performed in proper sequence;
 - 5. Remove or relocate existing utilities and pipes that obstruct the Work in locations where connections must be made;
 - 6. Make connections or alterations to existing or new facilities.
- C. Structural Elements: Do not cut or patch structural elements in a manner that would change the structural element's load-carrying capacity such as load deflection ratio.
- D. Operating Elements: Do not cut or patch operating elements in a manner that would reduce their capacity to perform as intended. Do not cut or patch operating elements or related components in manner that would increase maintenance requirements or decrease operational life or safety.

1.2 SUBMITTALS

- A. Provide the following submittals to the Engineer for review:
 - 1. Cutting and Patching Request:
 - a. Submit written request to the Engineer well in advance of executing any cutting or alteration that affects:
 - 1) Design function or intent of the Project.
 - 2) Work of the Owner or other contractors.
 - 3) Structural value or integrity of an element of the Project.
 - 4) Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
 - 5) Efficiency, operational life, maintenance, or safety of operational elements.
 - 6) Visual qualities of exposed elements.
 - b. The Contractor's written request shall include:
 - 1) Identification of the Project and contract name and number.
 - 2) Description of affected Work of the Contractor and/or work of others.
 - 3) Necessity for cutting.
 - 4) Effect on work of Owner or other contractors, or on structural or

weatherproof integrity of the Project.

- 5) Description of proposed Work, including but not limited to, scope of cutting and patching; trades who will be executing the Work; products proposed to be used; extent of refinishing; schedule of operations; alternatives to cutting and patching, if any.
 - 6) Designation of party responsible for cost of cutting and patching, when applicable.
 - 7) Written permission of other contractors whose work will be affected.
2. Should conditions of Work, or schedule, indicate a change of materials or methods, submit written recommendation to the Engineer including:
 - a. Conditions indicating change.
 - b. Recommendations for alternative materials or methods.
 - c. Submittals as required for substitutions.
 3. Submit written notice designating time Work will be uncovered, for inspection and/or observation by the Engineer and Owner. Do not begin cutting or patching operations until accepted by the Engineer.
- B. Conform to submittal requirements in the Specifications for application and installation of materials used for patching.

1.3 WARRANTY

- A. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials that do not void required or existing warranties.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials:
1. Use materials in conformance with the Contract Documents.
 2. If not shown or indicated in the Contract Documents, use materials and products that are identical to the existing materials and products affected by cutting and patching Work.
 3. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible. If identical materials are unavailable or cannot be used, use materials whose installed performance will equal or surpass that of existing materials.
 4. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using materials that do not void required or existing warranties
- B. Compound Applied to Core-Drilled Surfaces and Cut Concrete Surfaces: After core-drilling and before installing the utility or equipment through the penetration, coat exposed concrete and steel with solvent-free, two-component, epoxy protective coating...

PART 3 - EXECUTION

3.1 GENERAL

- A. Perform cutting and coring in a manner that limits the extent of patching.
- B. For penetrations through concrete and masonry walls, slabs, or arches, core drill holes unless otherwise accepted by the Engineer in writing.

3.2 INSPECTION

- A. Examine surfaces to be cut or patched and conditions under which cutting or patching are to be performed before commencing cutting or patching Work.
- B. Report unsatisfactory or questionable conditions to the Engineer in writing. Do not proceed with the Work until unsatisfactory conditions are corrected

3.3 PREPARATION

- A. Provide temporary support as required to maintain the structural integrity of the Project, to protect adjacent Work from damage during cutting, and to support the Work to be cut.
- B. Protect existing construction from damage during cutting and patching. Provide protection from adverse weather conditions for portions of the Project that will be exposed during cutting and patching operations.
- C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Do not cut existing pipe, conduit, ductwork, or other utilities serving facilities scheduled to be removed or relocated until provisions have been made to bypass them.

3.4 CORING

- A. Perform coring with a non-impact rotary tool using diamond core drills. Size holes for pipe, conduit, sleeves, equipment, or mechanical seals, as required.
- B. Protect existing equipment, utilities and adjacent areas from water and other damage during coring operations.
- C. Vacuum or otherwise remove slurry or tailings from the Work area following coring.
- D. Do not core-drill through electrical conduit or other utility lines embedded in walls or floors without approval of the Engineer. To the extent possible, avoid cutting reinforcing steel in floors and walls. After core-drilling, coat the exposed concrete and steel with Sika 62 or equal before installing the utility through the penetration.

3.5 CUTTING

- A. Cut existing construction using methods least likely to damage elements retained or adjoining construction, and that will provide proper surfaces to receive installation or repair.
 - 1. In general, use hand or small power tools designed for sawing or grinding, not hammering and chopping.
 - 2. Cut through concrete and masonry using a concrete wall saw with diamond saw blades.
 - a. Provide for control, on both sides of walls, of slurry generated by sawing.
- B. Cut holes and slots as small as possible, neatly to the size required, and with minimum disturbance of adjacent surfaces. Provide temporary covering over openings that are not in use.

- C. To avoid marring existing finished surfaces, cut or drill from exposed or finished side into concealed side.
- D. Provide adequate bracing of area to be cut prior to commencement of cutting.
- E. Provide equipment of adequate size to remove cut panel.
- F. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
- G. Maintain adequate ventilation when using cutting torches.

3.6 PATCHING

- A. Patch construction by filling, repairing, refinishing, closing-up and/or similar operations following performance of other Work.
 - 1. Closely match texture and finish of existing adjacent surface.
 - 2. Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
 - 3. Where patching smooth painted surfaces, extend final paint coat over entire unbroken surface containing the patch after the surface has received primer and second coat.
 - 4. Inspect and test patched areas to demonstrate integrity of the installation, where feasible.
 - 5. Provide materials and comply with installation requirements specified in the Contract Documents.
- A. Work shall be installed airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.
- B. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - 1. For continuous surfaces, refinish to nearest intersection.

3.7 CLEANING

- A. Clean areas and spaces where cutting, coring and patching are performed. Clean piping, conduit, or similar constructions before applying paint or other finishing materials. Restore damaged pipe covering to original condition.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
- B. Requirements in this Section are in addition to those specified in the General Conditions.

1.2 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following.
 - 1. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 2. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 3. Prepare and submit Project Record Documents including, but not limited to, electronic and hard copies of final "Reviewed" and "Reviewed and Noted" shop drawings and Operation and Maintenance Manuals, final completion construction photographic documentation, damage or settlement surveys, and similar final record information.
 - 4. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - 5. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 6. Complete startup testing of systems.
 - 7. Submit test/adjust/balance records.
 - 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 9. Advise Owner of changeover in heat and other utilities.
 - 10. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
 - 11. Complete final cleaning requirements, including touchup painting.
 - 12. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
 - 13. Schedule a walk through with the Owner and Engineer. A Certificate of Substantial Completion, including a list of items identified during the walk through to be completed

and corrected (punch list) shall be prepared by the Engineer.

1.3 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
 - 1. Submit a final Application for Payment according to General Conditions.
 - 2. Submit a certified copy of the Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 - 3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 - 4. Submit pest-control final inspection report and warranty.
 - 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings.
- B. Final Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 - 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. List will include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 - 1. List of spaces will be organized in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 - 2. Items applying to each space will be organized by major element, including categories for ceiling, individual walls, floors, equipment, and systems.
 - 3. List will include the estimated value of each item to be completed or corrected.

1.5 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Contract Documents.
 - 1. Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item.

Provide table of contents at beginning of document.

- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site and areas disturbed by construction activities of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Sweep concrete floors broom clean in unoccupied spaces.
 - i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - j. Remove labels that are not permanent.
 - k. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or

that already show evidence of repair or restoration.

- 1) Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates.
- l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
- m. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
- n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
- o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
- p. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter upon inspection.
- 1) Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report upon completion of cleaning.
- q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
- r. Leave Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare and submit report.
- D. Construction Waste Disposal: Comply with waste disposal requirements in Section entitled "Environmental Requirements for Construction."

END OF SECTION

SECTION 01 78 23

OPERATIONS & MAINTENANCE DATA

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide operation and maintenance data, in accordance with this Section and in accordance with requirements elsewhere in the Contract Documents, for use as instructional and reference manuals by operations and maintenance personnel at the Site.
- B. The required operation and maintenance data is specified in individual Sections of the Contract Documents, at a minimum, provide operation and maintenance data for:
 - 1. All equipment and systems.
 - 2. Valves, gates, actuators, and related accessories.
 - 3. Instrumentation and control devices.
 - 4. Electrical gear.
- C. For each operation and maintenance manual, submit the following:
 - 1. Preliminary Submittal: Printed and bound copy of entire operation and maintenance manual, except for test data, service reports by Supplier, and electronic copies.
 - 2. Final Submittal: Printed and bound copy of complete operations and maintenance manual, including test data and service reports by Supplier, with electronic copies.
- D. Prepare each operations and maintenance manual specifically for the Project. Include in each manual all pertinent instructions, as-built drawings (as applicable), bills of materials, installation and handling requirements, maintenance and repair instructions, and other printed materials required to provide accurate and comprehensive information for safe and proper operation, maintenance, and repair of equipment furnished for this Project. Include specific information required by applicable Specification Sections, and all data required by Laws and Regulations.

1.2 NUMBER OF COPIES AND TIMING OF SUBMITTALS:

- A. Preliminary Submittal:
 - 1. Printed Copies: Three (3) copies, exclusive of copies required by Contractor.
 - 2. Electronic Copies: Three (3) copies, comply with requirements of Section 01 33 00 Submittal Procedures for electronic format.
 - 3. Provide submittal to Engineer ten (10) days prior to starting training of operations and maintenance personnel, or ten days prior to field quality control testing at the Site; whichever is sooner
 - 4. Furnish preliminary operation and maintenance data submittal in acceptable form and content, as determined by Engineer, before associated materials and equipment will be eligible for payment.
- B. Final Submittal:
 - 1. Provide final submittal prior to Final Completion, unless otherwise specified in the Contract Documents.
 - 2. Printed Copies: Five (5) copies, exclusive of copies required by Contractor.

3. Electronic Copies: Five (5) copies, comply with requirements of Section 01 33 00 Submittal Procedures for electronic format.

1.3 FORMAT OF HARDCOPIES

A. Binding and Cover:

1. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy as required. Binders shall be minimum one-inch wide and maximum of three-inch wide. Binders for each copy of each volume shall be identical.
2. Binders shall be locking three-ring or three-post type. Three-ring binders shall be riveted to back cover and include plastic sheet lifter (page guard) at front of each volume.
3. Do not overfill binders.
4. Covers shall be oil, moisture, and wear resistant, and include identifying information on the cover and spine of the manual.
5. Provide the following information on the cover of each volume:
 - a. Title, "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of equipment covered in the manual.
 - c. Volume number, if more than one volume is required.
 - d. Name of Project and, if applicable, contract name and number.
6. Provide the following information on the spine of each volume:
 - a. Title, "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of equipment covered in the manual.
 - c. Volume number, if more than one volume is required.

B. Pages:

1. Print pages in manual on 30-pound (minimum) paper, 8.5 inches by 11 inches.
2. Provide each page with binding margin of at least one inch wide. Punch each page with holes suitable for the associated binding.

C. Drawings:

1. Bind drawings, diagrams, and illustrations into the manual using paper 11 by 17 inches in size, or smaller.
2. Documents larger than 11 inches by 17 inches shall be folded and inserted into clear plastic pockets bound into the manual. Mark pockets with printed text indicating content and drawing numbers. Provide no more than three drawings per pocket.

D. Copy Quality and Document Clarity:

1. Material shall be either original manufacturer-printed materials or first-generation photocopies indistinguishable from originals. Manuals that contain copies that are not clear, not completely legible, off-center, skewed, or where text or drawings are cut by binding holes, will be rejected. Pages that contain approval or date stamps, comments, or other markings that cover text or drawing are unacceptable. Faxed copies are unacceptable.
2. Clearly mark in ink all components of equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options provided or cross

out inapplicable material. Use of highlighters is unacceptable.

E. Organization:

1. Table of Contents:
 - a. Provide a table of contents in each volume of each operations and maintenance manual.
 - b. In the table of contents and at least once in each chapter or section, identify products by their functional names. Thereafter, abbreviations and acronyms may be used if their meaning is explained in a table bound at or near the end of each volume. Using product model or catalog designations for identification is not acceptable.
2. Use dividers and indexed tabs between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.

1.4 FORMAT OF ELECTRONIC COPIES

A. Electronic Copies of Manuals:

1. The electronic copy shall include all the information provided in the hardcopy.
2. Provide each electronic copy on a separate compact disc (CD).
3. File Format:
 - a. Files shall be in “portable document format (PDF)”. Files shall be electronically searchable.
 - b. Provide a separate file for each separate document in the hardcopy.
 - c. Within each file, provide bookmarks for the following:
 - 1) Each chapter and subsection listed in the hardcopy’s table of contents.
 - 2) Each figure.
 - 3) Each table.
 - 4) Each appendix.

B. Copies of Programming and Configuration Files:

1. Provide a CD copy of all software programming, such as programmable logic controller programs, prepared specifically for the Project. Third-party, commercially available software is excluded from requirements of this article; provide copies of commercially-available, third-party software as specified in the Contract Documents.
2. Provide CD copies of system configuration prepared specifically for the Project, such as SCADA display configurations.
3. Number of copies shall be as specified for electronic copies of operation and maintenance data.

1.5 CONTENT

- A. Provide complete, detailed, written operating instructions for each equipment including: function; operating characteristics; limiting conditions; operating instructions for start-up, normal conditions and emergency conditions; regulation and control; operational troubleshooting; and shutdown. Also, include, as applicable, written descriptions of alarms

generated by the equipment and proper responses to such alarm conditions.

- B. Provide written explanations of all safety considerations relating to operation and maintenance procedures.
- C. Provide complete, detailed, written preventive maintenance instructions including all information and instructions to keep the equipment or system properly lubricated, adjusted, and maintained so that the equipment functions economically throughout its design life. Instructions shall include:

- 1. Written explanations with illustrations for each preventive maintenance task such as inspection, adjustment, lubrication, calibration, and cleaning. Provide pre-startup checklists for each equipment item and maintenance requirements for long-term shutdowns.
- 2. Recommended schedule for each preventive maintenance task.
- 3. The Contractor shall furnish the Owner a lubrication chart(s) for all equipment furnished or installed by the Contractor. The chart(s) shall include the following for each item of equipment:
 - name of the item;
 - location of the item;
 - each point of lubrication on the item;
 - for each point of lubrication, the identification of the lubricant recommended and the recommended frequency of lubrication.

The information on the chart(s) shall be developed from manufacturers' printed data or from manufacturers' specific recommendations.

The identification of the lubricant by manufacturer's name and product identification number (such as Mobil X421) shall be furnished. Unless otherwise stated the name of the manufacturer to be used will be furnished to the Owner by the Contractor.

Following the initial operation of the equipment the Contractor shall relubricate, changing and adding lubricants, at the intervals or frequency as recommended by the manufacturer until acceptance.

- 4. Table of alternative lubricants.
- 5. Troubleshooting instructions.
- 6. List of required maintenance tools and equipment.
- D. Complete bills of material or parts lists for equipment provided. Lists or bills of material may be provided on a per-drawing or per-equipment assembly basis. Bills of material shall indicate:
 - 1. Manufacturer's name, address, telephone number, fax number, and Internet website address.
 - 2. Manufacturer's local service representative's or local parts supplier's name, address, phone number, fax number, and e-mail address, if applicable.
 - 3. The following information for each part or piece provided:
 - a. Parts cross-reference number. Cross-reference number shall be used to identify the part on the assembly drawing, Shop Drawing, or other type of illustration where the part is clearly shown.
 - b. Part name or description.

- c. Manufacturer's part number, serial number and shop order number.
 - d. Quantity of each part used in the assembly.
 - e. Current unit price of the part at the time the operations and maintenance manual is submitted. Price list shall be dated.
- E. Complete instructions for ordering replacement parts, including reference numbers (e.g., shop order or serial number) that will expedite the ordering process.
- F. Manufacturer's recommended inventory levels for spare parts and consumable supplies for the first two years of operation. Consumable supplies are those items consumed or worn during the operation of the equipment, and items used in maintaining the equipment such as lubricants and seals.
- G. Provide manufacturer's installation and operation bulletins, diagrams, schematics, and equipment cutaways. Avoid providing catalog excerpts unless they are the only material available showing the equipment. Where materials pertain to multiple models or types, mark the literature to indicate specific equipment supplied.
- H. Provide original-quality copies of each approved and accepted Shop Drawing and submittal, updated to as-installed condition.
- I. Provide electrical schematic and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
- J. Programmable Logic Controllers: If programmable logic controllers are furnished under the Contract:
 - 1. Submit complete logic listings in Owner selected format.
 - 2. Format Requirements:
 - a. For ladder diagram logic, include complete cross-referencing of all logic elements. Annotate all elements with clearly understandable tags or descriptive labels.
 - b. For function block diagram, label each function block with understandable tags or descriptive labels. Describe purpose and action of each function block.
 - c. For sequential function chart, include extensive comments for each step to describe program step function.
 - d. For instruction list and structured text, include extensive comments for each program line to describe program line function.
 - 3. Submit complete programmable logic controller listing of all input/output address assignments, tag assignments, and pre-set constant values, with functional point descriptions.
 - 4. Submit complete manufacturer's programming manuals.
- K. Copy of warranty and/or service contract as applicable.
- L. When copyrighted material is used in the operations and maintenance manual, obtain the copyright holder's written permission to use such material in the operation and maintenance manual.

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PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 78 40

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings
 - 2. Miscellaneous record submittals
- B. Requirements in this Section are in addition to those specified in the General Conditions.

1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal: Submit one paper copy set of marked-up record prints. Engineer will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal: Submit PDF electronic files of marked-up record prints. Print each Drawing, whether or not changes and additional information were recorded.
- B. Miscellaneous Record Submittals: Refer to other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding archive photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to:
 - a. Dimensional changes to Contract Drawings.

- b. Revisions to details shown on Contract Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Work Change Directive.
 - k. Changes made following the Engineer's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
- 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.
- 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
- 5. Mark important additional information that was either shown schematically or omitted from original Contract Drawings.
- 6. Note Work Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where the Engineer determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
 - 1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
 - 2. Consult the Engineer for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
 - 1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 - 2. Format: Annotated PDF electronic file with comment function enabled.
 - 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 - 4. Identification: As follows:
 - a. Project name.

- b. Date.
- c. Designation "PROJECT RECORD DRAWINGS."
- d. Name of Engineer and Construction Manager
- e. Name of Contractor

2.2 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file.
 - 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and modifications to project record documents as they occur; do not wait until the end of the Project.
- B. Maintenance of Record Documents and Samples: Store record documents in the field office apart from the Contract Documents used for construction. Do not use Project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project record documents for the Engineer's reference during normal working hours.

END OF SECTION

SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall furnish services of Manufacturer's operation and maintenance training specialists to instruct and demonstrate to the Owner's personnel in recommended operations and maintenance procedures for materials and equipment furnished, in accordance with the Contract Documents.
2. Manufacturer shall provide a combination of classroom and field training. All training shall be conducted at the Facility, unless otherwise stated in the equipment Sections. Class size shall be limited to no more than 15 trainees. Manufacturer shall provide training for all plant shifts, or as approved by Owner.

B. Scheduling of Training Sessions:

1. Contractor shall coordinate training services with start-up and initial operation of materials and equipment on days and times, and in manner, acceptable to Owner, in accordance with the Contract Documents.
2. Training may be required outside of normal business hours to accommodate schedules of operations and maintenance personnel. Furnish training services at the required days and times at no additional cost to Owner.
3. Training of Owner's personnel shall commence after acceptable preliminary operation and maintenance data has been submitted and approved. At option of Owner or Engineer, training may be allowed to take place before, during, or after equipment start-up.
4. Training Schedule Required: Contractor shall prepare and submit proposed training schedule for review and acceptance by Engineer and Owner. Proposed training schedule shall show all training required in the Contract Documents, and shall demonstrate compliance with specified training requirements relative to number of hours of training, number of training sessions, and scheduling.
5. Training Schedule Coordination: Project has multiple prime contracts; Contractors shall comply with this Section. All prime contractors shall coordinate with the General Contractor in developing a single training schedule submittal for the entire Project, to be submitted by General Contractor. All Contractors shall implement training in accordance with the approved training schedule.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer's instructors shall be factory-trained by manufacturer of material or equipment.
2. Manufacturer's instructors shall be proficient and experienced in conducting training of type required.
3. Qualifications of instructors are subject to acceptance by Engineer. If Engineer does not accept qualifications of proposed instructor, furnish services of replacement instructor

with acceptable qualifications.

1.3 SUBMITTALS

- A. Shop Drawings: Submit the following:
 - 1. Proposed Lesson Plan for each scheduled instruction fourteen (14) days prior to commencement of training. Lesson plans shall be approved a minimum of seven (7) days prior to scheduled instruction.
 - 2. Credentials of their designated operations and maintenance instructor. Credentials shall include a brief resume and specific details of the instructor's experience pertaining to operation of, maintenance of, and training for the equipment specified.
 - 3. Submit a written training request to the Engineer thirty (30) days prior to the requested training date.
 - 4. There shall be separate "Operations" and "Maintenance" staff training.

1.4 INSTRUCTION LESSON PLAN

- A. Manufacturer's proposed Lesson Plan shall include the requirements of Instruction Lesson Plan below in this Section. Specific components and procedures shall be identified in the proposed Lesson Plan.
- B. Manufacturer's proposed Lesson Plan shall detail specific instruction topics. Training aids to be utilized in the instruction shall be referenced and attached where applicable to the proposed Lesson Plan. "Hands-On" demonstrations planned for the instruction shall be described in the Lesson Plan.
- C. The manufacturer shall indicate the estimated duration of each segment of the training Lesson Plan.
- D. Instruction Lesson Plan shall include the following as a minimum:
 - 1. Equipment Operation:
 - a. Describe equipment's operating (process) function.
 - b. Describe equipment's fundamental operating principals and dynamics.
 - c. Identify equipment's mechanical, electrical and electronic components and features.
 - d. Identify all support equipment associated with the operation of subject equipment (e.g., air intake filters, valve actuators, motors).
 - e. Recommend standard operating procedures to cover start-up, routine monitoring and shutdown of the equipment.
 - 2. Detailed Component Description:
 - a. Identify and describe in detail each component's function.
 - b. Where applicable, group related components into subsystems. Describe subsystem functions and their interaction with other subsystems.
 - c. Identify and describe in detail equipment safeties and control interlocks.
 - 3. Equipment Preventive Maintenance, (PM):
 - a. Describe PM inspection procedures required to:
 - 1) Perform an inspection of the equipment in operation.

- 2) Spot potential trouble symptoms and anticipate breakdowns.
- 3) Forecast maintenance requirements (predictive maintenance).
- b. Define the recommended PM intervals for each component.
- c. Provide lubricant and replacement part recommendations and limitations.
- d. Describe appropriate cleaning practices and recommend intervals.
- e. Identify and describe the use of special tools required for maintenance of the equipment.
- f. Describe component removal/installation and disassembly/assembly procedures.
- g. Perform at least two “hands-on” demonstrations of preventive maintenance procedures.
- h. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
- i. Define recommended torquing, mounting, calibration and/or alignment procedures and settings, as appropriate.
- j. Describe recommended procedures to check/test equipment following a corrective repair.
4. Equipment Troubleshooting:
 - a. Define recommended systematic troubleshooting procedures.
 - b. Provide component specific troubleshooting checklists.
 - c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.

1.5 TRAINING AIDS

- A. The manufacturer’s instructor shall incorporate training aids as appropriate to assist in the instruction. As a minimum, the training aids shall include text and figure handouts. Other appropriate training aids are:
 1. Audio-Visual Aids (e.g., films, slides, videotapes, overhead transparencies, posters, blueprints, diagrams, catalogue sheets).
 2. Equipment cutaways and samples (e.g., spare parts and damaged equipment).
 3. Tools (e.g., repair tools, customized tools, measuring and calibrating instruments).
- B. The manufacturer’s instructor shall utilize descriptive class handouts during the instruction. Photocopied class handouts shall be good quality reproductions. Class handouts should accompany the instruction with frequent reference made to them. Customized handouts developed especially for the instruction are encouraged. Handouts planned for the instruction shall be attached with the manufacturer’s proposed Lesson Plan.
- C. Audio-visual Equipment: Training provider shall provide audio-visual equipment required for training sessions. Audio-visual equipment that training provider shall provide, as required, includes:
 1. Laptop computer, presentation software, and suitable projector.
 2. As required, extension cords and spare bulb for projector.

1.6 “HANDS-ON” DEMONSTRATIONS

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- A. The manufacturer's instructor shall present "hands-on" demonstrations of operations and maintenance of the equipment for each scheduled group. The proposed "hands-on" demonstrations should be described in the manufacturer's proposed Lesson Plan.

1.7 VIDEO RECORDING

- A. Contractor shall make a video recording of each training session and provide two (2) copies of each training session on DVDs to the Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 02 41 00

MOBILIZATION AND DEMOBILIZATION

PART 1 - GENERAL

1.1 SUMMARY

A. MOBILIZATION

1. Mobilization shall include obtaining all permits, moving equipment onto the site, furnishing and erecting temporary buildings and other construction facilities, implementing security requirements, and all other activities as required for the proper performance and completion of the Work.
2. Mobilization shall include the following principal items:
 - a. Moving all of the Contract's equipment required for operations onto the site;
 - b. Providing all on-site communication facilities, including radios and cellular phones;
 - c. Providing on-site sanitary facilities;
 - d. Obtaining all required permit;
 - e. Having all OSHA-required notices and establishment of safety programs;
 - f. Having all the Contractor's superintendents at the job site full time;
 - g. Submitting initial submittals;
 - h. Installation of Project Sign Display.

B. DEMOBILIZATION

1. Demobilization shall include the removing of all equipment from the site, removing any temporary buildings and other construction facilities, and removing all unused construction materials not previously agreed to be left with the Owner.

1.2 PAYMENT

- A. The Contractor's attention is directed to the condition that no payment for Mobilization, or any part thereof, will be approved for payment under the Contract Document until all Mobilization items listed above have been completed as specified.
- B. As soon as possible, after the receipt of the Notice to Proceed, the Contractor shall submit a breakdown showing the estimated value of each major component of Mobilization to

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the Engineer for approval. This shall include Demobilization at the end of the project. When approved by the Engineer, the breakdown will be the basis for initial progress payments in which the Mobilization is included.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

SECTION 02 41 19

DEMOLITION

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Work of this section includes portions of the existing wastewater treatment plant, sanitary sewer collection system and related structures as shown on the Drawings, but is not limited to:
 - 1. Complete Structural Demolition
 - a. Complete structural demolition.
 - b. Below-grade construction or demolition.
 - 2. Existing Utilities
 - a. Existing utilities remaining in use.
 - b. Existing utilities being shut down temporarily.
 - c. Existing utilities being removed.
 - d. Existing utilities being abandoned in place.

1.2 RELATED WORK

- A. Section 31 20 00 – Earthwork
- B. Division 26 - Electrical
- C. Division 33 – Utilities

1.3 SUBMITTALS

A. DEMOLITION SCHEDULE

- 1. Proposed methods and detailed sequence of operations.
- 2. Include coordination for shut-off, capping and continuation of utility services as required, together with details for dust and noise control protection.
- 3. Preliminary inspection report.
- 4. Work performance plan.
- 5. Final report.

B. PERMITS

1. Secure and pay for all required permits for and related to demolition activities.

1.4 JOB CONDITIONS

A. GENERAL

1. Any demolition indicated on the Drawings or in this section shall be for purposes of indicating the limits of demolition. Not indicated is the full extent or details for the existing items to be demolished.
2. Obtain Record Drawings, if any, from the Owner for reference. If there are Record Drawings, reliance cannot be made on such as to how extensive the demolition or the details of such due to the quality of the records and possible modifications to the original project.
3. The Contractor shall be responsible for all demolition and any consequences of demolition, no matter how extensive or the details of such, within the limits indicated on the Drawings or in this section.

B. OWNER OCCUPANCY

1. Conduct demolition work in manner that will minimize need for disruption of Owner's normal operations.
2. Provide minimum of 72 hours advance notice to Owner of demolition activities which will severely impact Owner's normal operations.

C. SALVABLE ITEMS

1. Items of salvable value to be retained by the Owner, as selected by the Owner, shall be moved by the Contractor to a location designated by the Owner and provide written permission from Owner.
2. Items of salvable value to the Contractor shall be removed from the site as the work progresses and transported from the site. Storage or sale of removed items on the site will not be permitted.

D. DAMAGES

1. Promptly repair damages caused to adjacent facilities by demolition operations, as directed by the Owner and at no cost to the Owner.

E. UTILITY SERVICES

1. Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.
 - a. Do not interrupt existing utilities serving occupied or used facilities, except where authorized in writing by the Owner. Provide temporary

services during interruptions to existing utilities, as acceptable to the Owner.

- b. Disconnect and seal utilities serving each area in which utilities are being removed.

F. EXPLOSIVES

1. The use of explosives shall not be permitted.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.1 INSPECTION

A. GENERAL

1. Prior to commencement of demolition work, inspect areas in which work will be performed.
2. Photograph existing conditions of structure surfaces, equipment, and surrounding properties which could be misconstrued as damage resulting from demolition work; submit prior to starting work.
3. Conduct any appropriate field testing to determine the nature of the existing structure to be demolished.

3.2 PREPARATION

A. GENERAL

1. Provide shoring, bracing, or support to prevent movement, settlement or collapse of structures to be demolished and adjacent facilities to remain.

B. DUST-PROOF PARTITIONS AND CLOSURES

1. Erect and maintain dust-proof partitions and closures as required to prevent spread of dust or fumes to adjacent buildings, site, and properties.

3.3 TANK CLEANING AND DISPOSAL

A. GENERAL

1. The Contractor shall remove and dispose of all materials (liquids, semi-liquids, sludges, grit, etc.) from the existing wastewater treatment tanks. All materials removed shall be disposed of offsite from the wastewater treatment plant.

B. PERMITS

1. The Contractor shall obtain all necessary permits from the City of Massillon, Stark County, Ohio EPA, or any other authority having jurisdiction prior to the disposal of any tank materials. The Contractor shall prepare all forms and applications to obtain disposal site approval.

C. DISPOSAL PLAN

1. The Contractor shall submit a disposal plan to the Engineer for review. This plan shall be submitted within 30 working days after receiving the written "Notice to Proceed".
2. The Contractor shall notify the Engineer of the disposal location prior to dewatering any tank.

3.4 DEMOLITION

A. GENERAL

1. Coordinate and sequence demolition with the Owner's Representative and Owner.
2. Locate demolition equipment throughout structure and remove.
3. Proceed with demolition in a systematic manner and coordinate all trades involved.
4. Demolish concrete and masonry in small sections. Cut concrete.
5. In addition to Demolition Drawings, refer to all other Drawings for demolition work.
6. The work includes the removal of items of existing construction not to remain as a part of the final Project.
7. Complete all demolition work in the area indicated, including any concealed items or any existing items not shown on the Drawings.
8. Remove materials completely and neatly, leaving surfaces smooth and ready for new work. Saw cut where necessary. Do not jackhammer as a means of cutting.
9. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations and as required by governing authorities. Return adjacent areas to condition existing prior to the start of the work.

B. PROTECTION AND SAFETY

1. Provide all protection, safety, and health requirements in accordance with OSHA, U.S. EPA, and other laws, regulations, and safe practices.
2. Ensure safe passage of persons around the area of demolition. Conduct operations to prevent injury to adjacent property and persons.
3. Protect existing work remaining in place.
4. Promptly repair damage caused to adjacent properties or existing construction not noted to be demolished at no change in the Contract Sum or Date of Substantial Completion.
5. Remove temporary protection at completion of work.

C. ENVIRONMENTAL CONTROLS

1. Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.
 - a. Do not use water when it may create hazardous or objectionable conditions such as flooding, pollution and electrical shock.

D. COMPLETE STRUCTURAL DEMOLITION

1. GENERAL

- a. Remove structures as indicated.
- b. Fill, compact and grade excavated areas resulting from the demolition of structures. Comply with Section 02200, Earthwork, for fill material and compaction requirements.

2. BELOW-GRADE CONSTRUCTION

- a. Demolish foundation walls to a depth of not less than 36" below existing ground surface, unless noted otherwise. Demolish and remove below-grade wood or metal construction. Break-up below-grade concrete slabs.

E. PROCESS PIPING

1. Remove existing process, water, chemical, gas, fuel oil, and other piping not required for the Work where indicated or where it will interfere with the Work.
2. Remove piping to the nearest solid support, cap and leave in place.
3. Purge volatile gases and make safe all process lines, fuel lines, and tanks prior to removal or capping.

4. Abandoned underground piping may be left in place unless it interferes with new Work or is shown or specified to be removed.

F. EXISTING UTILITIES

1. GENERAL

- a. Arrange timing of all shut-offs or shut-downs, removal or abandonment with the Owner. Do not shut-off or shut-down any utility without prior written approval of the Owner.

G. ELECTRICAL ITEMS

1. The Contractor shall remove all items as follows:

- a. Disconnect or shut off service to areas where electrical work is to be removed.
- b. Remove all electrical fixtures, equipment and related switches, outlets, conduit and wiring which are not to remain as a part of this Contract.

3.5 SALVAGE ITEMS

A. SALVAGE ITEMS REMOVED BY CONTRACTOR FOR OWNER REUSE

1. Items selected by the Owner shall be removed by the Contractor and stored on site where directed by the Owner, for reuse in remodeled areas or for storage for future reuse. All such items shall remain the property of the Owner.
2. Carefully remove and clean items and store for the Owner on the site where directed, for later reuse.
3. The following salvage items have been selected by the Owner for their future reuse:
 - a. First and second stage screw pump gear boxes.
 - b. First and second stage screw pump upper and lower bearings.
 - c. First and second stage screw pump grease pod.
 - d. First and second stage screw pump motors
 - e. All aluminum grating.
 - f. Check valve for floor drain under roughing towers located on first floor by the automatic samplers.
 - g. Boiler water recirculation pumps.

- h. Boiler heater pumps.
- i. First and second stage screw pump beam trolleys.
- j. Repair band (one) from west sludge blending tank overflow drain pipe
- k. Repair bands (two) from 4-inch waste gas piping in tunnel located by digester feed pumps.
- l. Two Wilo mixers and supports from sludge blending tanks.
- m. Hand rail from aeration tanks.
- n. Slide gate from mixed liquor recycle line.
- o. Slide gates for inlet to clarifier numbers 1, 2, and 3.
- p. Two 4-inch diameter magnetic flow meters from the tunnel area near the sludge blending tanks.

- B. Owner reserves the right to review all other items to be removed and retain any items he may require. Remove all other items from the site.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. GENERAL

- 1. All materials, equipment, fixtures and debris become the property of the Contractor and shall be removed from the site unless otherwise indicated.
- 2. Burning of removed materials shall not be permitted on the site.
- 3. Transport materials resulting from demolition operations and legally dispose of off the site in accordance with local, state, and federal requirements.
- 4. Items indicated to be removed but of salvable value to Contractor may be removed from structure as work progresses. Transport salvaged items from site as they are removed. Storage or sale of removed items on site shall not be permitted.

3.7 CLEANUP

A. GENERAL

- 1. Leave all areas graded, seeded and free of debris.

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, waterstops, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.
 - 4. Suspended slabs.
 - 5. Concrete toppings.
 - 6. Structure walls.
 - 7. Grade Beams.
 - 8. Columns and piers

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications (Contractor shall provide copies of all documents on-site), except where more stringent requirements are specified herein:
 - 1. American Concrete Institute (ACI)
 - a. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials.
 - b. ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
 - c. ACI 301 – Specification for Structural Concrete.
 - d. ACI 302 – Guide for Concrete Floor and Slab Construction.
 - e. ACI 304 – Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - f. ACI 305R - Hot Weather Concreting.
 - g. ACI 306R - Cold Weather Concreting.
 - h. ACI 308 - Standard Practice for Curing Concrete.
 - i. ACI 318 - Building Code Requirements for Structural Concrete.
 - j. ACI 350 – Environmental Engineering Concrete Structures.
 - k. ACI 350.1 and 350.1R – Tightness Testing of Environmental Engineering Concrete Structures and Commentary.
 - l. ACI 350.3R – Seismic Design of Liquid Containing Concrete Structures and Commentary.

2. American National Standards Institute (ANSI)
 - a. ANSI/ASTM A185 – Welded Steel Wire Fabric for Concrete Reinforcement.
3. American Society for Testing and Materials (ASTM)
 - a. ASTM A615 - Deformed and Plain Billet Steel for Concrete Reinforcement.
 - b. ASTM C33 - Concrete Aggregates.
 - c. ASTM C94 - Ready-Mixed Concrete.
 - d. ASTM C150 - Portland Cement.
 - e. ASTM C260 - Air Entraining Admixtures for Concrete.
 - f. ASTM C494 - Chemical Admixtures for Concrete.
4. Concrete Reinforcing Steel Institute (CRSI)
 - a. Manual of Standard Practice.
 - b. Design Handbook.

1.4 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.5 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Scheduling: Submit concrete placement schedule before start of placement operations. Include locations of all joints including construction joints.
- C. Product data for each type of manufactured material and product indicated, including reinforcement and forming accessories, admixtures, patching compounds, joint systems, dry-shake finish materials, fiber reinforcement, curing materials, floor and slab treatments, bonding agents and others, if requested by Owner's Representative.
- D. Written mix design shall be based on field experience or trial mixture. Submit documentation in accordance with ACI 301, Section 4.
 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- E. Shop drawings for detailing, fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, bent bar diagrams, arrangement, and support of concrete reinforcement. Include special reinforcing required for openings through concrete structures.
- F. Certificates: Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

- G. Test and Evaluation Reports: Provide laboratory test reports for concrete materials and mix designs.
- H. Manufacturer Instructions: Provide manufacturers literature for admixtures use in concrete mix.
- I. Source Quality Control Submittals: Provide certificates of source of cementitious materials and aggregate used in concrete mix.
- J. Special Procedure Submittals: Proposed method of concrete curing.
- K. Product Data: Provide product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, fiber reinforcement, and others if requested by engineer.
- L. Construction and Control Joints: Construction and control joints shall be located by the Contractor based on details and spacing limitations shown on the Contract Drawings. Shop drawings showing Contractors proposed joint location of construction and control joints and concrete placement sequencing shall be submitted to the Engineer for review prior to the preparation of reinforcement shop drawings and placement of concrete.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- C. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specification for Structural Concrete", Sections 1 through 5.
- D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- E. Pre-installation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Owner's representative.
 - b. Contractor's superintendent.
 - c. Independent testing agency responsible for concrete design mixtures.
 - d. Ready-mix concrete manufacturer.
 - e. Cast-in-place concrete subcontractor.
2. Review concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place concrete.

F. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.
2. Testing Firm Qualifications: An independent firm, with experience and capability to conduct specified tests, and is a member company of NETA or is an NRTL as defined by OSHA in 19 CFR 1910.7.
3. Testing Firm's Field Supervisor Qualifications: person currently certified by NETA or NICET to supervise on-site testing specified in Part 3.
4. Seismic Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing seismic engineering services, including the design of seismic restraints, that are similar to those indicated for this Project.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. The acceptability of steel reinforcement with rust, mill scale or a combination of both shall be determined based on the provisions of ACI 318 and applicable ASTM specifications.
- C. Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. General: Comply with Division 03 Section "Cast-In-Place Concrete" for formwork and other form-facing material requirements.
- B. Form-Facing Panels for As-Cast Finishes: Exterior-grade plywood panels, non-absorptive, that will provide continuous, true, and smooth concrete surfaces, medium-

density overlay, Class 1, or better, mill-applied release agent and edge sealed, complying with DOC PS 1.

- C. Rustication Strips: Metal, rigid plastic or dressed wood with sides beveled and back kerfed; non-staining; in longest practicable lengths.
- D. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch (19 by 19 mm), minimum; non-staining; in longest practicable lengths.
- E. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800, "Specification 810.1, Expanded Cellular Glazing Tape"; minimum 1/4 inch (6 mm) thick.
- F. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or S, Grade NS that adheres to form joint substrates.
- G. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.
- H. Form-Release Agent: Commercially formulated colorless form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of those surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- I. Surface Retarder: Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.
- J. Form Ties: Factory-fabricated, snap-off or removable metal ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish ties with tapered tie cone spreaders that, when removed, will leave holes 1-1/2 inches (38 mm) in diameter on concrete surface.
 - 2. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I/II, gray. Supplement with the following:
 - 2. Fly Ash: ASTM C 618, Class F.
 - 3. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 - 4. Silica Fume: ASTM C 1240, amorphous silica.

For cast-in-place concrete exposed to water, wastewater or groundwater, limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301, 318 and 350 requirements. Use fly ash, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by a minimum of 25 percent. Use one cement combination for the same application throughout the Project unless otherwise acceptable to Engineer.

- B. Normal-Weight Aggregates: ASTM C 33, Class 5S coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse Aggregate Size: 1 1/2 inch (25 mm) typical or 3/4" for concrete toppings.
 - 2. Gradation: Uniformly graded.
- C. Normal-Weight Fine Aggregate: ASTM C 33, manufactured or natural sand, from same source for entire Project.
- D. Water: Potable, complying with ASTM C 94/C 94M except free of wash water from mixer washout operations.

2.3 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260. Do not use air entrainment for interior concrete slabs to receive a trowel finish.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- C. Crystalline waterproofing admixture shall be Penetron® Admix or equal and shall meet the following requirements:
 - 1. Dosage Rate: 0.8% by weight of cementitious materials or as recommended by the manufacturer.
 - 2. Permeability: concrete treated with admixture shall resist a water pressure of 150 psi with no measurable leakage.
- D. Admixtures shall not be stored on-site.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
 - 1. Absorptive cover is not permitted for flatwork.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
 - 1. Use of moisture-retaining cover or moisture curing is required for flatwork.
 - 2. A minimum seven day curing period is required for flatwork.

- C. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
 - 1. Curing compound is not permitted for flatwork.
 - 2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

2.5 REPAIR MATERIALS

- A. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- B. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
 - 1. Types IV or V, for load bearing, or bonding hardened or freshly mixed concrete to hardened concrete.

2.6 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of cast-in-place concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.
- B. Proportion concrete mixtures as follows:
 - 1. Mix A - 4500-psi 28-day compressive strength; water-cement ratio 0.42 maximum; for use in all concrete exposed to water, wastewater or groundwater. Admixtures in the mix include crystalline waterproofing, air entraining and water reducing; a high-range water reducing admixture may be added if required to facilitate pumping.
 - 2. Mix B - 4000-psi 28-day compressive strength; water-cement ratio 0.45 maximum; for use in all other concrete work, unless noted otherwise. Admixtures in the mix include air entraining and water reducing; a high-range water reducer may be added if pumped.
 - 3. Swept-in-Grout Topping - 1 part Portland cement to 2-1/2 parts sand with minimum amount of water required for workability and placeability for swept-in-grout in primary and secondary clarifiers. Fiber reinforcement shall be added to the grout mixture for control of micro-cracking. Fiber reinforcement shall be as identified in this specification. Dosage rate shall be as specified and confirmed by the manufacturer.
 - 4. Concrete Fill - Concrete fill exposed to wastewater shall be 4500 psi, 28-day compressive strength; water-cement ratio 0.42 maximum. Other concrete fill shall be 2000-psi, 28-day compressive strength; water-cement ratio 0.67 maximum. Fiber reinforcement shall be added to fill mixtures for control of micro-cracking. Fiber reinforcement shall be as identified in this specification. Dosage rate shall be as specified and confirmed by the manufacturer. No admixtures are required except that a high-range water-reducing admixture may

be added, if required, to facilitate pumping. Use maximum acceptable aggregate size to satisfy the concrete fills dimensions.

- C. Cementitious Materials: For cast-in-place concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301, 318 and 350 requirements.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Admixtures: Use admixtures according to manufacturer's written instructions
- F. Use air-entraining admixture in exterior exposed concrete in Type A and B mix designs unless scheduled for a trowel finish or otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1 percent within the following limits.
 - 1. 5.5 percent for coarse aggregate size No. 467.
 - 2. 6 percent for coarse aggregate size No. 57 or No. 67.
 - 3. 7 percent for coarse aggregate size No. 7.

2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
 - 1. Clean equipment used to mix and deliver cast-in-place concrete to prevent contamination from other concrete.
 - 2. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

2.8 STEEL REINFORCEMENT AND ACCESSORIES

- A. Reinforcing bars shall be ASTM A615, Grade 60, deformed. Reinforcing bars to be welded shall be ASTM A706.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufacture according to CRSI's "Manual of Standard Practice."
 - 1. Where legs of wire bar supports contact forms, use gray, all-plastic bar supports.

2.9 NON-METALLIC FIBER REINFORCEMENT

- A. Fiber reinforcement shall be as scheduled below as manufactured by Fibermesh®, or equal. Dosage rate shall be as specified by the manufacturer. Use in strict accordance with the manufacturer's instructions.
 - 1. Fiber reinforcement for fiber-reinforced exterior slabs shall be Fibermesh® 300, or equal, applied at the application rate of 1.5 lbs. per cubic yard of concrete.

2. Fiber reinforcement for fiber-reinforced dry interior slabs shall be Fibermesh® 300, or equal, applied at the application rate of 1.5 lbs. per cubic yard of concrete.
3. Fiber reinforcement for fiber-reinforced submerged interior slabs shall be Novomesh® 950, or equal, applied at the application rate of 5.0 lbs. per cubic yard of concrete.
4. Fiber reinforcement for fiber-reinforced composite metal floor deck shall be Novomesh® 850, or equal, applied at the application rate of 24.0 lbs. per cubic yard of concrete.
5. Fiber reinforcement for fiber-reinforced submerged exterior concrete slabs, fillets and topping shall be Fibermesh® 300, or equal, applied at the application rate of 1.5 lbs. per cubic yard of concrete.

2.10 WATERSTOPS

- A. Standard waterstops shall be ribbed polyvinyl chloride (PVC) waterstops by the Paul Murphy Plastics Co., Vinylex Corporation, Greenstreak Co. or equal, at construction joints and control joints as indicated. Waterstops at expansion joints in new construction shall be ribbed, center-bulb type PVC. Waterstops for connection to future construction shall be ribbed or split-ribbed PVC. Thickness shall be 3/8-inch. Width shall be as indicated on the Contract Drawings. PVC waterstops shall meet Corps of Engineers CRD C572. Use in strict accordance with manufacturer's instructions. PVC waterstops shall be provided with integral hog rings to facilitate tie-off to reinforcing bars.
- B. Waterstops for use in chemical retaining structures shall be ribbed, center-bulb type thermoplastic rubber by Westec Barrier Technologies, or equal, at construction joints and control joints as indicated on the Contract Drawings. Thickness shall be 3/16-inch. Width shall be as indicated on the Contract Drawings.
- C. Flexible chloroprene rubber strips, such as Hydrotite Type CJ or RSS by the Greenstreak Plastic Products Co., Inc., Grace Adcor™ ES by Grace Construction Products, or equal, shall be used as swell-type waterstops in control joints, construction joints and cold joints where indicated on the Contract Drawings. Use in strict accordance with the manufacturer's instructions.

2.11 CONCRETE SURFACE SEALER

- A. Where noted on the Contract Drawings, concrete surface sealer shall be a transparent, odorless, water-based, chemically reactive penetrating sealer and hardener that seals by densifying concrete. Concrete surface sealer shall be Ashford Formula by Curecrete Distribution, Inc.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Limit deflection of form-facing panels to not exceed ACI 347 requirements.
- B. In addition to ACI 347 limits on form-facing panel deflection, limit cast-in-place concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class B, 1/8 inch.
- C. Fabricate forms to result in cast-in-place concrete that complies with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.
 1. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
 2. Do not use rust-stained steel form-facing material.
- E. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- F. Chamfer exterior corners and edges of cast-in-place concrete.
- G. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.
- H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- L. Coat contact surfaces of forms with surface retarder, according to manufacturer's written instructions, before placing reinforcement.
- M. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting. Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

3.2 REINFORCEMENT AND INSERTS

- A. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.

- B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.3 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Schedule form removal to maintain surface appearance that matches approved field sample panels.
 - 2. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.
- B. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved 28-day design compressive strength. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- C. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.
- D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast-in-place concrete surfaces.

3.4 JOINTS

- A. Construction and control joints shall be located by the Contractor based on details and spacing limitations shown on the Contract Drawings. Shop drawings showing Contractors proposed joint location of construction and control joints and concrete placement sequencing shall be submitted to the Engineer for review prior to the preparation of reinforcement shop drawings and placement of concrete.
- B. Construction Joints: Install construction joints true to line with faces perpendicular to surface plane of cast-in-place concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete. Align construction joint within rustications attached to form-facing material.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

6. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints: Form weakened-plane contraction joints true to line with faces perpendicular to surface plane of cast-in-place concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer. If approved by Engineer, provide written documentation including date and time, location, reason and quantity of water added.
- C. Before test sampling and placing concrete, water may be added at Project site, up to the limits of the specified water-cement ratio and slump, subject to limitations of ACI 301. This presumes that not all mixing water is added at the batching plant.
 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.
- E. Cold-Weather Placement: Comply with ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
 4. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.
 5. Provide written documentation of compliance with ACI 306 provisions, including temperature logs of concrete during placement and curing.

- F. Hot-Weather Placement: Comply with ACI 305 and as follows:
1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
 3. Provide written documentation of compliance with ACI 305 provisions, including temperature logs of concrete during placement and curing.
- G. Concrete Washout: In advance of concrete placements, coordinate wash out area for concrete trucks with Owner's Representative and Owner. Washout of concrete trucks shall not be permitted on-site, unless written permission is provided by the Owner. If permitted on-site, washout of trucks shall be performed in a single location throughout the project and comply with USEPA best management practices.

3.6 QUALITY CONTROL DURING CONSTRUCTION

- A. The Contractor shall employ a testing agency, approved by the Engineer, to perform tests and to submit test reports. Field testing to be performed by an ACI certified concrete field testing technician grade I.
- B. Sampling and testing for quality control during concrete placement may include the following, as directed by Engineer.
1. Sampling Fresh Concrete: ASTM C172, except modified for slump to comply with ASTM C94.
 - a. Slump testing shall be in accordance with ASTM C143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - b. Air content testing shall be in accordance with ASTM C173, volumetric method for lightweight or normal weight concrete; ASTM C231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
 - c. Testing of concrete temperature shall be in accordance with ASTM C1064; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
 - d. Molding of cylinders for compression testing shall be in accordance with ASTM C31; one set of six standard 6-inch dia. cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
 - e. Compressive-strength testing shall be in accordance with ASTM C 39; one set for each 100 cu. yd. or fraction thereof, of each concrete mix placed in any one day; two specimens tested at 7 days, two specimens tested at 28 days, and two specimens retained in reserve for later testing, if required.

2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
 3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 4. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- C. Test results will be reported in writing to Owner, Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- D. Nondestructive testing shall consist of impact hammer, sonoscope, or other nondestructive device but shall not be used as the sole basis for acceptance or rejection.
- E. The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed.
- F. In addition to the testing noted above, the Owner or Owner's Representative will engage a qualified independent testing and inspecting agency to perform special inspections as required by the 2011 Ohio Building Code.

3.7 REMOVING FORMS

- A. Formwork not supporting the weight of concrete, such as sides of walls, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, concrete is able to support its own weight and provided curing and protection operations are maintained.
- B. Formwork supporting the weight of concrete, such as slabs and other structural elements, may be removed in less than 14 days but in no case until concrete has attained at least 75 percent of design minimum compressive strength at 28 days, unless otherwise noted. Determine representative compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

- D. Cleaning Forms: In advance of concrete placements, coordinate area for cleaning forms with Owner's Representative and Owner. Cleaning of forms shall be performed in a single location on-site and resulting debris shall be removed from the site and properly disposed.

3.8 REUSING FORMS

- A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Owner's Representative.

3.9 CONCRETE SURFACE REPAIRS (NEW CONCRETE)

- A. Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Owner's Representative.
- B. Mix dry-pack mortar, consisting of 1 part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
 - 1. Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
 - 2. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- C. Remove and replace formed concrete having defective surfaces if defects cannot be repaired to satisfaction of Owner's Representative. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.
 - 1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.
- D. Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified.

Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
 3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Owner's Representative.
 4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- E. Repair isolated random cracks and single holes 1 inch or less in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Place dry-pack before bonding agent has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- F. Perform structural repairs with prior acceptance by Owner's Representative and Owner for method and procedure, using specified epoxy adhesive and mortar.
- G. Repair methods not specified above may be used, subject to acceptance of Owner's Representative.

3.10 FINISHES, GENERAL

- A. Concrete Finish: Provide a rough-formed finish on exterior formed concrete surfaces located below grade in the finished Work or permanently concealed by other construction. Provide smooth-rubbed finish on exterior formed concrete surfaces located above grade. Provide smooth-rubbed finish on interior formed concrete surfaces, including interior surfaces of tank walls.
- B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

C. Monolithic Slab Finishes.

1. Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or waterproofing; and where indicated.
2. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F/F 18 (floor flatness) and F/L 15 (floor levelness) measured according to ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
3. Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with paint or another thin film-finish coating system.
4. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances of F/F 20 (floor flatness) and F/L 17 (floor levelness) measured according to ASTM E1155. Grind smooth any surface defects that would telegraph through applied floor covering system.

D. Apply a nonslip rough broom finish to exterior concrete equipment pads, walking surfaces and elsewhere as indicated.

Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

E. Maintain uniformity of special finishes over construction joints, unless otherwise indicated.

3.11 AS-CAST FORMED FINISHES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding specified limits on formed-surface irregularities.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair and patch tie holes and defects.
- C. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:
 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until

producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part Portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match surrounding concrete. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part Portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match surrounding concrete. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

- D. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

3.12 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306 for cold-weather protection and with ACI 305 for hot-weather protection during curing.
- B. Begin curing cast-in-place concrete immediately after removing forms from concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:
 1. Moisture Curing: Keep exposed surfaces of cast-in-place concrete continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period; use cover material and waterproof tape.
 3. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period. Curing compound is not permitted for flatwork.
 4. Moisture curing or Moisture-retaining-cover curing is required for flatwork (including concrete toppings). A minimum 7 day curing period is required for flatwork.

- C. Concrete Sealer: Apply concrete surface sealer to interior concrete slabs where indicated on the Contract Drawings. Install and protect concrete surface sealer in accordance with the manufacturer's written installation instructions. For concrete surfaces to be sealed, do not use curing compounds.

3.13 LEAKAGE TESTING

- A. Leakage testing of fluid containing structures shall be conducted in accordance with the Section "Leakage Test for Hydraulic Concrete Structures".
- B. Structures that fail the leak test shall be repaired and re-tested.

END OF SECTION

SECTION 03 31 00

LEAKAGE TESTS FOR HYDRAULIC CONCRETE STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies leakage tests of new hydraulic concrete structures.
 - 1. The General Contractor shall furnish labor, equipment, clean water and materials necessary for carrying out leakage tests.
 - 2. Testing shall meet the requirements of ACI 350.1.
- B. Testing shall be witnessed by the Owner's designated Representative.

1.2 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following items shall also be submitted:
 - 1. Reports of test results.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 LEAKAGE TESTS FOR HYDRAULIC CONCRETE STRUCTURES

- A. Tanks, vaults, channels and other fluid-containing concrete structures shall be leak tested according to ACI standard hydrostatic test with criterion HST-050 (maximum allowable loss of 0.050% per day). Unless otherwise directed by the Owner's Representative, the leak testing shall be performed prior to backfilling around the structures and the installation of internal process components.
 - 1. Concrete structures shall be filled with clean water at least 72 hours before the test is started.
 - 2. Once the test is started, the water level shall be observed and recorded at 24-hour intervals.
 - 3. The test period shall be continued for the duration sufficient to cause a 3/8" drop in the water surface assuming the loss of water is at the maximum rate.
 - 4. The test period need not be longer than five days.
- B. The exterior surface, especially at construction and expansion joints, will be visually inspected for leakage during leakage testing according to ACI standard hydrostatic test with criterion HST-VIO (visual inspection only).
 - 1. No flow or seepage of water from the tank shall be present on the exterior surfaces for 24 hours after the tank is filled to test level.
 - 2. A slight dampness on the exterior wall surface during the test period will not be considered leakage.
- C. The Contractor will be permitted to immediately retest a tank failing to meet the HST-050 criterion when no visible leakage is apparent.

1. If the tank fails the second test or the Contractor does not exercise the option of immediately retesting after the first test failure, the interior of the tank shall be inspected by a diver, hired by the Contractor, or by other means to determine probable areas of leakage.
2. The tank shall only be retested after the most probable areas of leakage are repaired.
3. Tanks shall be retested until they meet the required criterion.
4. Repairs shall be made to the probable leakage areas before each retest.

END OF SECTION

SECTION 03 41 13

PRECAST CONCRETE HOLLOW CORE PLANKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplemental Conditions or General Provisions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes precast prestressed hollow core slabs as indicated on Drawings.
- B. Precast prestressed long-span units and precast prestressed structural framing members are specified in other sections of this Division.

1.3 SUBMITTALS

- A. General. Submit the following in accordance with conditions of Contract and Division 1 specification sections.
- B. Product data and instructions for manufactured materials and products. Include manufacturer's certifications and laboratory test reports as required.
- C. Shop drawings showing complete information for fabrication and installation of precast concrete units. Indicate member dimensions and cross-section as well as location, size, and type of reinforcement, including special reinforcement and lifting devices necessary for handling and erection.
- D. Provide layout, dimensions, and identification of each precast unit corresponding to sequence and procedure of installation. Indicate welded connections by AWS standard symbols. Detail inserts, connections, and joints, including accessories and construction at openings in precast units.
- E. Provide complete design calculations prepared by a registered engineer licensed in state where project is erected.

1.4 QUALITY ASSURANCE

- A. Codes and Standards. Comply with provisions of following codes, specifications, and standards, except as otherwise indicated:
 - 1. ACI 301 "Specifications for Structural Concrete for Buildings."
 - 2. ACI 318 "Building Code Requirements for Reinforced Concrete."

3. Prestressed Concrete Institute MNL-116, "Manual for Quality Control for Plants and Production of Precast Concrete Products."
- B. Fabricator Qualifications. Firms with at least two successful experiences in fabrication of precast concrete units similar to units required for this project will be acceptable.
 1. Fabricator must be producer member of the Prestressed Concrete Institute (PCI) and/or participate in its Plant Certification Program.
 2. Produce precast concrete units at fabricating plant engaged primarily in manufacturing of similar units.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver precast concrete units to project site in such quantities and at such times to assure continuity of installation. Store units at project site to prevent cracking, distortion, staining, or other physical damage and so that markings are visible. Lift and support units at designated lift points.

1.6 FIELD CONDITIONS

- A. Design modifications may be made as necessary to meet field conditions, to ensure proper fitting of work, and as acceptable to Engineer. Changes to general design concept as shown must be acceptable to Engineer.
- B. Deliver anchorage items that are to be embedded in other construction before start of such work. Provide setting diagrams, templates, and directions as required for installation.

PART 2 - PRODUCTS

2.1 PRESTRESSING TENDONS

- A. Uncoated, 7-wire stress-relieved or low relaxation strand complying with ASTM A 416. Use Grade 250 unless Grade 270 indicated.
- B. Strand similar to above, but having size and ultimate strength of wires increased so that ultimate strength of the strand is increased approximately 15 percent, or strand with increased strength but with fewer wires per strand, may be used at manufacturer's option.

2.2 CONCRETE MATERIALS

- A. Subject to exceptions and clarifications given in this section, all cement, aggregates, admixtures, and other materials used in the formulation of concrete for precast units shall comply with the requirements of Section 03300, Cast-In-Place Concrete.

- B. Cement Grout. Portland cement, ASTM C 150, Type I, and clean natural sand, ASTM C 404. Mix at ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum water required for placement and hydration.
- C. Vulcanized, chloroprene, elastomeric compound, molded to size or cut from a molded sheet, 50-60 Shore A durometer, conforming to ASTM D 2000.

2.3 PROPORTIONING AND DESIGN OF MIXES

- A. General. Prepare design mixes for each type of concrete required.
- B. Design mixes may be prepared by an independent testing facility or by qualified precast manufacturing plant personnel, at precast manufacturer's option.
 - 1. Produce standard-weight concrete consisting of specified portland cement, aggregates, admixtures, and water to produce the following properties:
 - a. Compressive strength: 5,000 psi minimum at 28 days.
 - b. Release strength for prestressed units: 3,500 psi.
 - 2. Cure compression test cylinders by the same methods used for precast concrete work.
- C. Admixtures. Use water-reducing admixtures in strict compliance with manufacturer's directions. Admixtures to increase cement dispersion or provide increased workability for low-slump concrete may be used if acceptable to Engineer.
- D. Use amounts as recommended by admixture manufacturer for climatic conditions prevailing at time of placing. Adjust quantities of admixtures as required to maintain quality control.

2.4 FABRICATION

- A. General. Fabricate precast concrete units complying with manufacturing and testing procedures, quality control recommendations, and dimensional tolerances of PCI MNL-116.
- B. Accurately construct forms of sufficient strength to withstand pressures due to concrete placing operations, temperature changes, and pretensioning and detensioning operations. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated, within specified fabrication tolerances.
- C. Furnish units that are free of voids or honeycomb, with straight true edges and surfaces.
- D. Finish. Unless indicated otherwise, provide units with normal plant run finish produced in forms that impart a smooth finish to concrete. Small surface holes caused by air bubbles, normal form joint marks, and minor chips and spalls will be tolerated, but major or unsightly imperfections, honeycomb or structural defects will not be permitted.

1. Composite Finish. Where indicated, provide roughed surface with $\frac{1}{4}$ inch undulations for composite bond as required in ACI 318.
- E. Adequately reinforce slab units to resist transporting and handling stresses.
- F. Dimensional Tolerances. Fabricate hollow core slab units to comply with PCI MNL-116 fabricated dimensional tolerances.

PART 3 - - EXECUTION

3.1 INSTALLATION

- A. Lift, place, and secure hollow slab units in accordance with manufacturer's printed instructions and final shop drawings, keeping units tight and perpendicular to bearing supports. Do not install hollow slab units until supporting members are in place and secured.
- B. Follow erection procedures and sequence of erection as recommended by hollow slab unit manufacturer and as acceptable to Engineer.
- C. Installation Tolerances. Install precast units without exceeding following tolerance limits:
 1. Variations from Plumb: $\frac{1}{4}$ inch in any 20-foot run or story height; $\frac{1}{2}$ inch total in any 40-foot or longer run.
 2. Variations from Level or Elevation: $\frac{1}{4}$ inch in any 20-foot run; $\frac{1}{2}$ inch in any 40 foot run; total plus or minus $\frac{1}{2}$ inch at any location.
 3. Variation from Position in Plan: Plus or minus $\frac{1}{2}$ inch maximum at any location.
 4. Offsets in Alignment of Adjacent Members at Any Joint: $\frac{1}{16}$ inch in any 10-foot run, $\frac{1}{4}$ inch maximum.
- D. Level slabs accurately to uniform slopes as indicated.
- E. Set slabs on solid, level bearing, with bearing surface of slab units not less than 2 inches at steel supports and not less than 3 inches at other supports, unless otherwise acceptable to Engineer.
- F. Align and level by methods, procedures, and equipment as recommended by hollow slab unit manufacturer.
- G. Do not cut holes or install sleeves larger than size permitted by hollow slab unit manufacturer for pipe, conduits, duct, or other penetrations after fabrication.
- H. Do not cut reinforcing or prestressing strands without approval of manufacturer.

- I. Field cut holes for openings that do not disturb prestressing strands in accordance with recommendations of hollow slab unit manufacturer.
- J. At continuous electrical raceway joints, carefully align cells and tape butt joints in accordance with manufacturer's recommendations and to comply with applicable code requirements. Keep hollow cores free from grout and other foreign materials.
- K. Grout joints and repair damaged exposed surfaces. Place forms or other acceptable method to retain grout in place until sufficiently hard to support itself. Completely fill void with grout to finish smooth and level with adjacent surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.

3.2 PLANT QUALITY CONTROL EVALUATIONS

- A. The Owner may employ a separate testing laboratory to evaluate precast manufacturer's quality control and testing methods.
- B. The precast manufacturer shall allow Owner's testing facility access to materials storage areas, concrete production equipment, and concrete placement and curing facilities. Cooperate with Owner's testing laboratory and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.
- C. Dimensional Tolerances. Units having dimensions smaller or greater than required, and outside specified tolerance limits, may be subject to additional testing as herein specified.
- D. Precast units having dimensions greater than required will be rejected if appearance of function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units as required to meet construction conditions.
- E. Strength of Units. Strength of precast concrete units will be considered potentially deficient if manufacturing processes fail to comply with requirements that may affect strength of precast units, including the following conditions.
 - 1. Failure to meet compressive strength test requirements.
 - 2. Reinforcement, and pretensioning and detensioning of tendons of prestressed concrete, not conforming to specified fabrication requirements.
 - 3. Concrete curing, and protection of precast units against extremes in temperature, not as specified.
 - 4. Precast units damaged during handling and erection.
- F. Testing Precast Units. Where there is evidence that strength of precast concrete units does not meet specification requirements, the concrete testing service shall take cores drilled

from hardened concrete for compressive strength determination, complying with ASTM C 42 and as follows:

1. Take at least three representative cores from precast units of suspect strength from locations directed by Engineer.
 2. Test cores in a saturated-surface-dry condition per ACI 318 if concrete will be wet during use of completed structure.
 3. Test cores in an air-dry condition per ACI 318 if concrete will be dry during use of completed structure.
 4. Strength of concrete for each series of cores will be considered satisfactory if their average compressive strength is at least 85 percent of 28-day design compressive strength.
 5. Test results will be made in writing with copies to Engineer, Contractor, and precast manufacturer. Include in test report the project identification name and number, date, name of precast concrete manufacturer, name of concrete testing service, identification letter, number, and type of member or members represented by core tests, design compression strength, compressive breaking strength and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of concrete as placed, and moisture condition of core at time of testing.
- G. Patching. Where core test results in satisfactory and precast units are acceptable for use in work, fill core holes solid with patching mortar and finish to match adjacent concrete surfaces.
- H. Defective Work. Precast concrete units that do not conform to specified requirements, including strength, tolerances, and finishes, shall be replaced with precast concrete units that meet requirements of this section. Contractor shall also be responsible for cost of corrections to other work affected by or resulting from corrections to precast concrete work. Engineer shall solely determine the usability and/or replacement of damaged materials. All materials rejected by the Engineer shall immediately be removed from the project site.

SECTION 04 22 00
UNIT CONCRETE MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes concrete unit masonry consisting of the following as shown on the Contract Documents:
 - 1. Concrete masonry units.
 - 2. Clay unit masonry in the form of brick.
 - 3. Pre-faced concrete masonry units.
 - 4. Steel reinforcing bars.
 - 5. Mortar and grout.
 - 6. Masonry joint reinforcement.
 - 7. Ties and anchors.
 - 8. Embedded flashing.
 - 9. Insulation in masonry walls.
 - 10. Miscellaneous masonry accessories.

1.2 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.4 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Contractor will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
 2. Mortar Test (Property Specification): For each mix required, according to ASTM C 109/C 109M for compressive strength[, ASTM C 1506 for water retention, and ASTM C 91 for air content].
 3. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
 4. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.
 5. Prism Test: For each type of construction required, according to ASTM C 1314.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection:
1. Decorative CMUs, in the form of small-scale units.
 2. Colored mortar.
 3. Weep holes/vents.
- D. Samples for Verification: For each type and color of the following:
1. Decorative CMUs.

2. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
 3. Accessories embedded in masonry.
- E. Qualification Data: For testing agency.
- F. Material Certificates: For each type and size of the following:
1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 2. Cementitious materials. Include brand, type, and name of manufacturer.
 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 4. Grout mixes. Include description of type and proportions of ingredients.
 5. Reinforcing bars.
 6. Joint reinforcement.
 7. Anchors, ties, and metal accessories.
- G. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
 3. Grout Mix Design: Include description of type and proportions of grout ingredients in accordance with ASTM C476.
- H. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

- I. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.
- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
- D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.
- E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 01 Section "Quality Requirements" for mockups.
 - 1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches long by 48 inches high by full thickness.
 - 2. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
 - 3. Protect approved sample panels from the elements with weather-resistant membrane.
 - 4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.
 - 5. Retain and maintain sample panels during construction in undisturbed condition as standards for judging completed unit masonry construction.
 - 6. Notify Engineer one week in advance of the dates and times when panels will be erected.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

1.8 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bull nose units for outside corners unless otherwise indicated.

- B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.

- a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block .
- 2) ACM Chemistries, Inc.; RainBloc.
- 3) BASF Aktiengesellschaft; Rheopel Plus.
- 4) Or approved equal.

- C. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi 14.8 MPa.
2. Density Classification: Normal weight.

3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
4. Exposed Faces: Match existing on surrounding buildings
5. Do not use aggregates made from pumice, scoria, or tuff.
6. Provide Type I, moisture-controlled units.

D. Clay Masonry Units

1. Face Brick Standard: ASTM C 216 and as follows:
 - a. Grade: SW.
 - b. Type: FBS.
 - c. Size. Standard modular (3 inches thick by 2 1/4 inches high by 7 inches long).
 - d. Color and Texture: Provide face brick of color and texture to match existing brickwork on the Administration Building. Acceptability of proposed brick will be judged by the Engineer from sample panels erected by the Contractor.

2.3 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color matching existing on surrounding buildings.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of Portland cement complying with ASTM C 150, Type I or Type III and hydrated lime complying with ASTM C 207 containing no other ingredients.
 1. For pigmented mortars, use colored Portland cement-lime mix of formulation required to produce color matching existing. Pigments shall not exceed 10 percent of Portland cement by weight for mineral oxides nor 2 percent for carbon black.
 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Color Mortar Blend; Glen-Gery Corporation.
 - b. Centurion Colorbond PL; Lafarge Corporation.

- c. Lehigh Custom Color Portland/Lime; Lehigh Portland Cement Co.
 - d. Riverton Portland Cement Lime Custom Color; Riverton Corporation (The).
 - e. Or approved equal
- D. Masonry Cement: ASTM C 91.
- 1. For pigmented mortars, use premixed, colored masonry cements of formulation required to produce color matching existing on surrounding buildings. Pigments shall not exceed 5 percent of masonry cement by weight for mineral oxides nor 1 percent for carbon black.
 - 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cemex S.A.B. de C.V.; Citadel Type S Dixie Type S.
 - b. Lehigh Cement Company; Lehigh Masonry Cement.
 - c. National Cement Company, Inc.; Coosa Masonry Cement.
 - d. Brixment-in-Color; Essroc Materials, Inc.
 - e. Centurion Colorbond; Lafarge Corporation.
 - f. Lehigh Custom Color Masonry Cement; Lehigh Portland Cement Co.
 - g. Flamingo Color Masonry Cement; Riverton Corporation (The).
 - h. Or equal.
- E. Mortar Cement: ASTM C 1329.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lafarge North America Inc.; Lafarge Mortar Cement or Magnolia Superbond Mortar Cement.
 - b. Cemex S.A.B. de C.V.
 - c. Lehigh Cement Company
 - d. Or approved equal

- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Davis Colors; True Tone Mortar Colors.
 - b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
 - c. Solomon Colors, Inc.; SGS Mortar Colors.
 - d. Centurion Pigments; Lafarge Corporation.
 - e. Or approved equal
- G. Colored Cement Product: Packaged blend made from portland cement and hydrated lime, masonry cement or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Colored Portland Cement-Lime Mix:
 - 1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
 - 2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
 - 3) Lafarge North America Inc.; Eaglebond Portland & Lime.
 - 4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
 - 5) Or approved equal
 - b. Colored Masonry Cement:
 - 1) Capital Materials Corporation; Flamingo Color Masonry Cement.
 - 2) Cemex S.A.B. de C.V.; Richcolor Masonry Cement.
 - 3) Essroc, Italcementi Group; Brixment-in-Color.
 - 4) Holcim (US) Inc.; Rainbow Mortamix Custom Color Masonry Cement.
 - 5) Lafarge North America Inc.; U.S. Cement Custom Color Masonry Cement.
 - 6) Lehigh Cement Company; Lehigh Custom Color Masonry Cement.
 - 7) National Cement Company, Inc.; Coosa Masonry Cement.
 - 8) Or approved equal
 2. Formulate blend as required to produce color matching existing surrounding buildings.

- H. Aggregate for Mortar: ASTM C 144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
 - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- I. Aggregate for Grout: ASTM C 404.
- J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Euclid Chemical Company (The); Accelguard 80.
 - b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
 - c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.
 - d. Or approved equal
- K. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs, containing integral water repellent by same manufacturer.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ACM Chemistries, Inc.; RainBloc for Mortar.
 - b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.
 - c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
 - d. Or approved equal.
- L. Water: Potable.

- M. Ready-Mixed Mortar: Cementitious materials, water, and aggregate complying with requirements specified in this Article; combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C 1142.
- N. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for, and approved by manufacturer of, structural clay tile facing units; in color indicated or, if not otherwise indicated, as selected by owners representative from manufacturer's standard colors.

2.4 REINFORCEMENT

- A. Steel Reinforcing Bars: Material and grade as follows:
 - 1. Billet steel complying with ASTM A 615 (ASTM A 615M).
 - a. Grade 60.
 - 2. Epoxy-coated billet steel complying with ASTM A 615 (ASTM A 615M) and ASTM A 775 (ASTM A 775M).
 - a. Grade 60 (Grade 400).
- B. Deformed Reinforcing Wire: ASTM A 496, with ASTM A 153, Class B-2 zinc coating.
- C. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
 - 1. Interior Walls: Hot-dip galvanized, carbon steel.
 - 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 - 3. Wire Size for Side Rods: 0.187-inch diameter.
 - 4. Wire Size for Cross Rods: 0.187-inch diameter.
 - 5. Wire Size for Veneer Ties: 0.187-inch diameter.
 - 6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 - 7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
- D. Masonry Joint Reinforcement for Single-Wythe Masonry: Truss type with single pair of side rods.
- E. Masonry Joint Reinforcement for Multi-Wythe Masonry, provide type as follows:

1. Adjustable (2-piece) tab design with single pair of side rods and rectangular box-type cross ties spaced not more than 16 inches o.c., with side rods spaced for embedment within each face shell of back-up wythe and with separate adjustable ties engaging the cross ties and extended to engage the outer wythe by at least 1-1/2 inches and spaced not more than 16 inches o.c.
2. Use where horizontal joints of facing wythe do not align with those of back-up.

2.5 TIES AND ANCHORS

- A. General: Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of this Article, unless otherwise indicated.
- B. Wire: As follows:
 1. Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating.
 2. Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 641 (ASTM A 641M), Class 1 coating for wire ties and anchors in interior walls.
 3. Wire Diameter: 0.25 inch (6.4 mm).
- C. Steel Sheet: As follows:
 1. Stainless-Steel Sheet: ASTM A 167, Type 304 or 316.
- D. Stainless-Steel Sheet Thickness: As follows:
 1. 0.0625 inch (1.6 mm).
- E. Galvanized Heavy-Thickness Steel Sheet: ASTM A 635 (ASTM A 635M) (commercial quality) hot-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153, Class B-2 or B-3, as applicable, for rigid anchors fabricated from steel sheet or strip with a thickness of 0.180 inch (4.6 mm) and greater.
- F. Steel Plates and Bars: ASTM A 36 (ASTM A 36M), shop painted with 2 coats of coal-tar epoxy-polyamide paint complying with SSPC-Paint 16 to comply with SSPC-PA 1 for painting and SSPC-SP 6 for surface preparation.
- G. Steel Plates and Bars: ASTM A 36 (ASTM A 36M), hot-dip galvanized to comply with ASTM A 153, Class B-1, B-2, or B-3, as applicable to size and form indicated.
- H. Stainless-Steel Plates, Bars, and Dowels: ASTM A 167, ASTM A 276, or ASTM A 666, Type 304 or 316; temper as required to support loads imposed without exceeding allowable design stresses.

2.6 MISCELLANEOUS ANCHORS

- A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron inserts of type and size indicated.
- B. Dovetail Slots: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.0336-inch (0.85-mm), galvanized steel sheet.
- C. Anchor Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of diameter and length indicated and in the following configurations:
 - 1. Headed bolts.
 - 2. Nonheaded bolts, straight.
 - 3. Nonheaded bolts, bent in manner indicated.
- D. Postinstalled Anchors: Anchors as described below, with capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Type: Chemical anchors.
 - 2. Type: Expansion anchors.
 - 3. Type: Undercut anchors.
 - 4. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts; ASTM A 167 or ASTM A 276, Type 304 or 316, for anchors.
 - 5. For Postinstalled Anchors in Concrete: Capability to sustain, without failure, a load equal to 4 times the loads imposed by masonry.

2.7 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
 - 1. Copper: ASTM B 370, Temper H00, cold-rolled copper sheet, 12-oz./sq. ft. (3.7-kg/sq. m) weight or 0.0162 inch (0.41 mm) thick.
 - 2. Stainless Steel 0.0156 inch (28 gauge) thick.

3. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
4. Adhesive for Flashings: Of type recommended by manufacturer of flashing material for use indicated.
5. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Copper Fabric; AFCO Products, Inc.
 - 2) Type FCC-Fabric Covered Copper; Phoenix Building Products.
 - 3) Copper Fabric Flashing; Sandell Manufacturing Co., Inc.
 - 4) York Copper Fabric Flashing; York Manufacturing, Inc.
 - 5) Or equal
6. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees[and hemmed].

2.8 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Type 2, Class A, Grade 1; compressible up to 35 percent; of width and thickness indicated; formulated from the following material:
 1. Neoprene.
 2. Urethane.
 3. Polyvinyl chloride.
- B. Preformed Control-Joint Gaskets: Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
 1. Styrene-Butadiene Rubber Compound: ASTM D 2000, Designation M2AA-805.
 2. Polyvinyl Chloride: ASTM D 2287, General Purpose Grade, Type PVC-65406.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep Holes: Provide the following:
 1. Plastic Weep Hole/Vent: One-piece, flexible extrusion manufactured from ultraviolet-resistant polypropylene copolymer, designed to weep moisture in masonry cavity to exterior, sized to fill head joints with outside face held back 1/8 inch from exterior face of masonry, in color selected from manufacturer's standard.

2. Available Products: Subject to compliance with requirements, weep hole/ventilators that may be incorporated in the Work include, but are not limited to, the following:
 - a. Plastic Weep Hole/Vent:
 - b. Cell Vent; Dur-O-Wal, Inc.
- E. Cavity Drainage Material: 1-inch- thick, reticulated, nonabsorbent mesh, made from polyethylene strands and shaped to maintain drainage at weep holes without being clogged by mortar droppings.
 1. Product: Subject to compliance with requirements, provide "Mortar Net" by AA Wire Products Co.

2.9 MASONRY-CELL INSULATION

- A. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Concrete Block Insulating Systems; Korfil.
 - b. Shelter Enterprises Inc.; Omni Core.
 - c. Conform Global; Smart Block,
 - d. Or approved equal

2.10 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.
- B. Proprietary Acidic Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.
 1. For masonry not subject to metallic oxidation stains, use formulation consisting of a concentrated blend of surface-acting acids, chelating, and wetting agents.

2. For dark-colored masonry not subject to metallic oxidation stains, use formulation consisting of a liquid blend of surface-acting acids and special inhibitors.
3. For masonry subject to metallic oxidation stains, use formulation consisting of a liquid blend of organic and inorganic acids and special inhibitors.
4. Available Products: Subject to compliance with requirements, products that may be used to clean unit masonry surfaces include, but are not limited to, the following:
 - a. 202 New Masonry Detergent; Diedrich Technologies, Inc.
 - b. 200 Lime Solv; Diedrich Technologies, Inc.
 - c. 202V Vana-Stop; Diedrich Technologies, Inc.
 - d. Sure Klean No. 600 Detergent; ProSoCo, Inc.
 - e. Sure Klean No. 101 Lime Solvent; ProSoCo., Inc.
 - f. Sure Klean Vana Trol; ProSoCo, Inc.

2.11 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 1. Do not use calcium chloride in mortar or grout.
 2. Add cold-weather admixture (if used) at the same rate for all mortar, regardless of weather conditions, in order to ensure that mortar color is consistent.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below:
 1. Limit cementitious materials in mortar to portland cement and lime.
 2. Limit cementitious materials in mortar for exterior use to portland cement and lime.
 3. For masonry below grade, in contact with earth, and where indicated, use type indicated below:
 - a. Type: S.
 4. For reinforced masonry and where indicated, use type indicated below:

- a. Type: S.
- 5. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions, and for other applications where another type is not indicated, use type indicated below:
 - a. Type: N.
- C. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required.
 - 1. Limit pigments to the following percentages of cement content by weight:
 - a. For mineral oxide pigments and portland cement-lime mortar, not more than 10 percent.
 - b. For carbon-black pigment and portland cement-lime mortar, not more than 2 percent.
 - c. For mineral oxide pigments and masonry cement mortar, not more than 5 percent.
 - d. For carbon-black pigment and masonry cement mortar, not more than 1 percent.
- D. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates combined with selected cementitious materials.
 - 1. Mix to match Owner's Representative selected sample.
- E. Grout for Unit Masonry: Comply with ASTM C 476. Use grout of consistency indicated or, if not otherwise indicated, of consistency (fine or coarse) at time of placement that will completely fill spaces intended to receive grout.
 - 1. Use fine grout in grout spaces less than 2 inches in horizontal dimension, unless otherwise indicated.
 - 2. Use coarse grout in grout spaces 2 inches or more in least horizontal dimension, unless otherwise indicated.
- F. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's directions.

2.12 SOURCE QUALITY CONTROL

- A. The Contractor will employ and pay a qualified independent testing agency to perform the following testing for source quality control. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.
- B. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested for strength, absorption, and moisture content per ASTM C 140.
- C. Brick Tests. For each type and grade of brick indicated, units will be tested by qualified independent testing laboratory per ASTM C67, except 5 bricks will be selected at random for each 100,000 units or fraction thereof installed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 - 1. Install compressible filler in joint between top of partition and underside of structure above.
 - 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.
 - 3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 2. Allow cleaned surfaces to dry before setting.
 3. Wet joint surfaces thoroughly before applying mortar.
- D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
1. Space reinforcement not more than 16 inches o.c.
 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.

3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 1. Install preformed control-joint gaskets designed to fit standard sash block.
- C. Form expansion joints in exterior concrete masonry as follows:
 1. Form open joint of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 7 Section "Joint Sealants." Maintain joint free and clear of mortar.
- D. Build-in horizontal pressure-relieving joints where indicated; construct joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 7 Section "Joint Sealants."
 1. Locate horizontal pressure-relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.8 MASONRY-CELL INSULATION

- A. Install molded polystyrene insulation units in masonry unit cells before laying units.

3.9 LINTELS

- A. Install steel lintels where indicated.
- B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

1. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 FLASHING

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.
- B. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer before covering with mortar.
- C. Install flashing as follows:
 1. At composite masonry walls, including cavity walls, extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4 inches, and through the inner wythe to within 1/2 inch of the interior face of the wall in exposed masonry. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches, unless otherwise indicated.
 2. At lintels and shelf angles, extend flashing a minimum of 4 inches into masonry at each end. At heads and sills, extend flashing 4 inches at ends and turn up not less than 2 inches to form a pan.
 3. Cut off flashing flush with face of wall after masonry wall construction is completed.
- D. Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashing and as follows:
 1. Form weep holes with product specified in Part 2 of this Section.
 2. Space weep holes 24 inches o.c.
 3. In cavities, place pea gravel to a height equal to height of first course, but not less than 2 inches, immediately above top of flashing embedded in the wall, as masonry construction progresses, to splatter mortar droppings and to maintain drainage.
 4. Place cavity drainage material immediately above flashing in cavities.
- E. Install vents in vertical head joints at the top of each continuous cavity. Space vents and close off cavities vertically and horizontally with blocking in manner indicated.
 1. Install through-wall flashing and weep holes above horizontal blocking.

- F. Install reglets and nailers for flashing and other related construction where shown to be built into masonry.

3.11 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
 - 3. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
 - a. Do not exceed the following pour heights for fine grout:
 - b. For minimum widths of grout spaces of 3/4 inch or for minimum grout space of hollow unit cells of 1-1/2 by 2 inches, pour height of 12 inches.
 - c. For minimum widths of grout spaces of 2 inches or for minimum grout space of hollow unit cells of 2 by 3 inches, pour height of 60 inches.
 - d. For minimum widths of grout spaces of 2-1/2 inches or for minimum grout space of hollow unit cells of 2-1/2 by 3 inches, pour height of 12 feet.
 - e. For minimum widths of grout spaces of 3 inches or for minimum grout space of hollow unit cells of 3 by 3 inches, pour height of 24 feet.
 - 4. Do not exceed the following pour heights for coarse grout:
 - a. For minimum widths of grout spaces of 1-1/2 inches or for minimum grout space of hollow unit cells of 1-1/2 by 3 inches, pour height of 12 inches.
 - b. For minimum widths of grout spaces of 2 inches or for minimum grout space of hollow unit cells of 2-1/2 by 3 inches, pour height of 60 inches.
 - c. For minimum widths of grout spaces of 2-1/2 inches or for minimum grout space of hollow unit cells of 3 by 3 inches, pour height of 12 feet.
 - d. For minimum widths of grout spaces of 3 inches or for minimum grout space of hollow unit cells of 3 by 4 inches, pour height of 24 feet.

5. Provide cleanout holes at least 3 inches in least dimension for grout pours over 60 inches in height.
 - a. Provide cleanout holes at each vertical reinforcing bar.
 - b. At solid grouted masonry, provide cleanout holes at not more than 32 inches o.c.

3.12 FIELD QUALITY CONTROL

- A. The Owner will employ and pay a qualified independent testing agency to perform the following testing for field quality control. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.
- B. Testing Frequency: Tests and Evaluations listed in this Article will be performed during construction for each 5000 sq. ft. (460 sq. m) of wall area or portion thereof.
- C. Mortar properties will be tested per property specification of ASTM C 270.
- D. Mortar composition and properties will be evaluated per ASTM C 780.
- E. Grout will be sampled and tested for compressive strength per ASTM C 1019.
- F. Prism-Test Method: For each type of wall construction indicated, masonry prisms will be tested per ASTM E 447, Method B, and as follows:
 1. Prepare 1 set of prisms for testing at 7 days and 1 set for testing at 28 days.

3.13 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.14 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 1. Crush masonry waste to less than 4 inches in each dimension.
 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earth Moving."
 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes structural steel, as shown on the Contract Drawings, complete including framing members, base and anchor plates, connections, grouting under base and anchor plates, fabrication, delivery and installation.

1.2 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements are specified herein:
1. American Society for Testing and Materials (ASTM)
 - a. ASTM A6 - General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling.
 - b. ASTM A36 - Carbon Structural Steel.
 - c. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - d. ASTM A108 - Steel Bars, Carbon, Cold-Finished, Standard Quality.
 - e. ASTM A123 - Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products.
 - f. ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.
 - g. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - h. ASTM A325 - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - i. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
 - j. ASTM A992, Grade 50 - Structural Steel Shapes.
 - k. ASTM F959 - Compressible - Washer - Type Direct Tension Indicators for Use with Structural Fasteners.
 - l. ASTM F1554 - Anchor Bolts, Steel, 36, 55 and 105 KSI Yield Strength.
 2. American Welding Society
 - a. AWS D1.1 - Structural Welding Code.
 - b. AWS A2.0 - Standard Welding Symbols.
 3. American Institute of Steel Construction
 - a. AISC - Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
 4. SSPC - Steel Structures Painting Council.
 5. Research Council on Structural Connections (RCSC) Specification for Structural Joints Using A325 or A490 bolts.

1.3 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following items shall also be submitted:

- B. Product data for each type of product indicated.
- C. Shop drawings showing fabrication of structural-steel components.
 - 1. Include profiles, sizes, spacing and locations of structural members, details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 3. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical, high-strength bolted connections.
- D. Manufacturer's certificates, certifying welders employed on the Work, verifying AWS qualifications within the previous 12 months.
- E. Mill test reports signed by manufacturers certifying that the following products comply with requirements:
 - 1. Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Direct-tension indicators.
 - 4. Tension-control, high-strength bolt-nut-washer assemblies.
 - 5. Shop primers.
 - 6. Non-shrink grout.

1.4 QUALITY ASSURANCE

- A. Fabricator qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work. Fabricator shall have AISC Category I, II or III Quality Certification.
- B. Installer qualifications: Engage an experienced Installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- C. Perform work in accordance with the applicable provisions of the following specifications and documents:
 - 1. AISC, "Specification for the Design and Erection of Structural Steel for Buildings."
 - a. Connections, unless noted otherwise on the Contract Documents, shall be designed for standard end loads as determined by the uniform load constants indicated in the AISC Manual of Steel Construction. Connections shall be made with double clip angles unless otherwise indicated on the Contract documents. Shop standards shall be used to the largest extent possible.
 - b. Design connections not detailed on the Contract Drawings under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Ohio.
 - 2. AISC, "Specification for Allowable Stress Design of Single-Angle Members."
 - 3. AISC, "Seismic Provisions for Structural Steel Buildings."
 - 4. ASTM A6, "Specification for General Requirements for Rolled Steel Plates, Shapes, and Bars for Structural Use."

5. Research Council on Structural Connections (RCSC), "Specification for Structural Joints Using ASTM A 325 or A490 Bolts."
 6. AWS D1.1, "Structural Welding Code".
- D. Professional Engineer shall be a licensed engineer legally authorized to practice in the State of Ohio and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver structural steel to project site in such quantities and at such times to ensure continuity of installation.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.6 FIELD MEASUREMENTS

- A. Verify that field measurements are as shown on Contract Drawings.

1.7 SEQUENCING

- A. Supply anchorage items to be embedded in, or attached to, other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Not applicable.

2.2 MATERIALS AND CONSTRUCTION

- A. W-Shapes shall comply with ASTM A992, Grade 50, high strength steel.
- B. Steel channels, angles, plates and threaded rods shall comply with ASTM A36, carbon steel.
- C. Pipe shall comply with ASTM A53, Grade B.
- D. Structural steel tubes shall comply with ASTM A500, Grade B.

- E. Anchor rods shall comply with ASTM F1554, Grade 36.
- F. Bolts, nuts, and washers shall meet ASTM A325.
 - 1. Direct Tension Indicators (DTI's) shall comply with ASTM F959 Type 325 compressible washer type.
 - 2. Provide beveled washers for S-shapes and channels.
- G. Welding materials shall meet AWS D1.1, type required for materials being welded.
- H. Grout shall be a non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water-reducing and plasticizing additives, capable of developing a minimum compressive strength of 7,000 psi at 28 days.
- I. Primer shall be fast curing, lead and chromate free, universal primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS-TT-P-664. Primer shall be compatible with finish paint system.

2.3 FABRICATION

- A. Fabricate and assemble in shop to greatest extent possible. Fabricate items according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC specifications referenced in this section, and as indicated on final shop drawings.
 - 1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials. Coordinate with Owner's Representative for fabrication sequence.
 - 2. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
 - 3. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
 - 4. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.
 - 5. Provide cambered structural-steel members where indicated.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning. Drill holes in bearing plates.
 - 2. Weld threaded nuts to framing and other specialty items indicated to receive other work.

- F. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure, free of marking, burns and other defects.

2.4 FINISH

- A. Prepare structural component surfaces in accordance with SSPC specifications. Exposed structural steel shall receive a finish paint system.
- B. Surface preparation, primer and finish coating shall be as specified in the specification entitled "Painting."

2.5 SHOP CONNECTIONS

- A. High Strength Bolts: Shop-install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
- B. Welded Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - 1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examination
 - 1. Verify that field conditions are acceptable and are ready to receive work.
 - 2. Beginning of installation means erector accepts existing conditions.
- B. Setting Bases and Bearing Plates
 - 1. Remove bond-reducing materials from all concrete and masonry bearing surfaces and roughen to improve bond to surfaces. Clean the bottom surface of base and bearing plates.
 - 2. Set loose and attached base plates and bearing plates for structural members or wedges or other adjusting devices. A minimum of 4 anchor bolts shall be used for column base plates.
 - 3. Weld plate washers to top of base plate.
 - 4. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
 - 5. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Erection

1. Allow for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.
2. Erect structural steel accurately in locations and to elevations indicated and according to AISC specs referenced in this section.
3. Field weld components indicated on Contract Drawings. Components shall be free of primer and paint prior to field welding.
4. Do not field cut or alter structural members without prior notification to Owner's Representative.
5. After erection, prime welds, abrasions, and surfaces not shop primed except surfaces to be in contact with concrete.
6. Level and plumb individual members of structures within specified AISC tolerances.
7. Align and plumb edges of roof edge angle as dimensioned on contract drawings.

D. FIELD CONNECTIONS

1. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - a. Fully pre-tensioned connections, as indicated on the Contract Drawings, shall be pre-tensioned and fully tightened $\frac{3}{4}$ inch dia. A325 bolts. Minimum pretension for fully tightened $\frac{3}{4}$ inch dia. bolts shall be 28 kips. Direct tension indicators shall be used at these connections to assure that bolts are properly installed and tensioned.
2. Welded Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work. Field weld components indicated on Contract Drawings. Components shall be free of primer and paint prior to field welding.

3.2 QUALITY CONTROL

- A. Testing Agency: The Owner or Owner's Representative will engage a qualified independent testing and inspecting agency to perform special inspections as required by the 2011 Ohio Building Code.
- B. Bolted Connections: Bolted connections shall be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Welded connections shall be inspected according to AWS D1.1.
- D. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION

SECTION 05 31 00

STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes steel roof and floor deck, as shown on the Contract Drawings, complete including deck closures, pour stops, roof drain sump pans, connections and accessories, fabrication, delivery and installation.

1.2 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements are specified herein:
 - 1. American Society for Testing and Materials International (ASTM)
 - a. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - b. ASTM A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
 - 2. American Welding Society (AWS)
 - a. AWS D1.1 - Structural Welding Code - Steel
 - b. AWS D1.3 - Structural Welding Code - Sheet Steel
 - 3. The Society for Protective Coatings (SSPC)
 - a. SSPC-Paint 20 – Zinc-Rich Coating, Type I – Inorganic and Type II - Organic
 - 4. Steel Deck Institute (SDI)
 - a. Design Manual for Composite Decks, Form Decks and Roof Decks – Publication No. 31

1.3 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following items shall also be submitted:
 - 1. Product data for each type of deck, accessory, and product specified.
 - 2. Shop drawings showing layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.
 - 3. Product certificates signed by manufacturers of steel deck certifying that their products comply with specified requirements.

1.4 QUALITY ASSURANCE

Engage an experienced Installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Roof Deck, Inc.
 - 2. United Steel Deck, Inc., subsidiary of Bouras Industries Inc.
 - 3. Vulcraft Corp., division of Nucor Corp.
 - 4. Or equal.

2.2 MATERIALS AND CONSTRUCTION

- A. Fabricate panels without top-flange stiffening grooves conforming to SDI Publication No. 31 and the following:
 - 1. Galvanized-steel sheet shall comply with ASTM A653 (ASTM A653M).
 - 2. Roof deck profile depth shall be 1-1/2 inches. Floor deck profile depth shall be 2 inches.
 - 3. Design uncoated-steel thickness shall be 20 ga. minimum, unless indicated otherwise.
 - 4. Span condition shall be as indicated.
 - 5. Fastening pattern shall be as indicated.
 - 6. Side joints shall be overlapped or interlocking seam at Contractor's option with screwed fasteners.

2.3 ACCESSORIES

- A. Provide accessory materials for steel deck that comply with requirements indicated and recommendations of the steel deck manufacturer.
- B. Side lap fasteners shall be manufacturer's standard, corrosion-resistant, hexagonal washer head; self-drilling, carbon steel screws, No. 10 minimum diameter.
- C. Rib closure strips shall be manufacturer's standard vulcanized, closed-cell, synthetic rubber.
- D. Deck closures shall be steel sheet, 20 ga., of same material as floor deck. Pour stops shall be steel sheet, of same material as the floor deck and thickness as indicated.
- E. Steel sheet accessories shall comply with ASTM A653 (ASTM A653M).

- F. Galvanizing repair paint shall be SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examination
1. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel deck.
- B. Preparation
1. Do not place deck panels on concrete supporting structure until concrete has cured and is dry.
 2. Locate decking bundles to prevent overloading of supporting members.
- C. Deck Erection
1. Install deck panels and accessories according to applicable specifications and commentary of SDI Publication No. 31, manufacturer's recommendations, and requirements of this Section.
 2. Install temporary shoring before placing deck panels when required to meet deflection limitations.
 3. Place deck panels on supporting framing and adjust to final position with ends accurately aligned and bearing on supporting framing before being permanently fastened. Do not stretch or contract side lap interlocks.
 4. Place deck panels flat and square and fasten to supporting framing without warp or deflection.
 5. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to the decking.
 6. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work.
 7. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.

3.2 REPAIRS AND PROTECTION

- A. Prepare and repair damaged galvanized coatings on both surfaces with galvanized repair paint according to ASTM A780 and the manufacturer's instructions.
- B. Provide final protection and maintain conditions to ensure steel decking is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes miscellaneous metal fabrications as shown on the Contract Drawings, complete including fabrication, shop finishing and installation.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements are specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM A36 - Carbon Structural Steel.
 - b. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - e. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - f. ASTM A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications.
 - g. ASTM A194 - Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - h. ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - i. ASTM A276 - Stainless Steel Bars and Shapes
 - j. ASTM A283 - Low and Intermediate Tensile Strength Carbon Steel Plates.
 - k. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - l. ASTM A325 - Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength.
 - m. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
 - n. ASTM A992 - Structural Steel Shapes.
 - o. ASTM B177 - Engineering Chromium Electroplating.
 - p. ASTM B221 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - q. ASTM B308 - Aluminum-Alloy 6061-T6 Standard Structural Profiles.
 - r. ASTM F1554 - Anchor bolts, Steel, 36, 55, and 105-KSI Yield Strength.

2. American Welding Society (AWS)
 - a. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
 - b. AWS D1.1 - Structural Welding Code-Steel.
 - c. AWS D1.2 - Structural Welding Code-Aluminum.
3. SSPC - Steel Structures Painting Council.

1.4 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following items shall also be submitted:
 1. Shop drawings indicating profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 2. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with the following:
 1. Prepare shop drawings under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Ohio.
 2. Use certified welders employed on the Work, with verification of AWS qualification within the previous 12 months.

1.6 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

PART 2 - PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

- A. Structural steel W-shapes shall be ASTM A992, Grade 50.
- B. Steel M, S, C, MC and L-shapes, plates and threaded rods shall be ASTM A36.
- C. Steel anchor bolts shall be ASTM F1554, Grade 36.
- D. Aluminum sections shall be ASTM B308, Alloy 6061-T6.
- E. Steel tubing shall be ASTM A500, Grade B.
- F. Steel pipe shall be ASTM A53, Grade B, Schedule 40. Bollards shall be Schedule 80.
- G. Bolts, nuts, and washers for structural steel connections shall be ASTM A325, galvanized to ASTM A153 for galvanized components.
- H. Stainless steel extrusions shall comply with ASTM A269, Type 304 or 316.

- I. Stainless steel bolts shall be ASTM A193, Type 304 or 316, grade B8 or B8M.
- J. Stainless steel nuts shall be ASTM A194, Type 304 or 316, grade 8 or 8M.
- K. Stainless steel washers shall be ANSI B18.22.1.
- L. Welding materials shall comply with AWS D1.1 or AWS D1.2; type required for materials being welded.
- M. Adhesive anchors for solid base substrates shall be a two-component adhesive system supplied in manufacturer's standard side-by-side or co-axial cartridge dispensed through a static mixing nozzle. System shall be capable of anchoring internally threaded inserts, threaded rods and steel reinforcing. Adhesive anchor system shall be one of the following:
 - 1. For applications above 40°F, use one of the following:
 - a. HIT HY 200 MAX or HIT RE 500 Injection Adhesive system by HILTI, Inc.
 - b. SET High Strength Epoxy system by Simpson Strong-Tie
 - 2. For applications below 40°F, use one of the following:
 - a. HIT-ICE Injection Adhesive system by HILTI, Inc.
 - b. ACRYLIC-TIE system by Simpson Strong-Tie
- N. Adhesive anchors for hollow base substrates shall be a two-component adhesive system supplied in manufacturer's standard side-by-side or co-axial cartridge dispensed through a static mixing nozzle. System shall be capable of anchoring internally threaded inserts, threaded rods and steel reinforcing. Adhesive anchor system shall be one of the following:
 - 1. For applications above 40°F, use one of the following:
 - a. HIT HY 70 Injection Adhesive system with screen tube by HILTI, Inc.
 - b. SET High Strength Epoxy system with screen tube by Simpson Strong-Tie
 - 2. For applications below 40°F, consult manufacturer for recommendation.
- O. Expansion bolts shall be HSL Expansion anchors by HILTI, Inc. or WEDGE-ALL wedge anchors by Simpson Strong-Tie.
- P. Primer for steel shall be fast-curing, lead and chromate free, universal primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS-TT-P-664. Primer shall be compatible with finish paint system.

2.2 FABRICATION

- A. Fit and shop assemble in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

- D. Exposed mechanical fastenings shall consist of flush countersunk screws or bolts, unobtrusively located, consistent with design of component, except where specifically noted otherwise.
- E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.3 FINISHES

- A. Surface preparation, primer and finish coatings shall be as specified in the Section entitled "Painting."
- B. Do not prime surfaces in direct contact with concrete or where field welding is required.
- C. Items to be galvanized shall be given a minimum 2.0 oz/sq ft zinc coating in accordance with ASTM A123.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examination
 - 1. Verify that field conditions are acceptable and are ready to receive work.
 - 2. Beginning of installation means erector accepts existing conditions.
- B. Preparation
 - 1. Clean and strip primed steel items to bare metal where site welding is required.
 - 2. Supply items required to be cast into concrete or embedded in masonry with setting templates.
- C. Erection
 - 1. Install items plumb and level, accurately fitted, free from distortion or defects.
 - 2. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
 - 3. Field weld components indicated on shop drawings.
 - 4. Perform field welding in accordance with AWS D1.1 or AWS D1.2.
- D. Erection Tolerances
 - 1. Maximum variation from plumb shall be 1/4 inch per 10 feet, non-cumulative.
 - 2. Maximum offset from true alignment shall be 1/4 inch.
- E. Schedule
 - 1. Bollards shall be steel pipe, concrete filled, crowned cap, size as detailed; galvanized.
 - 2. Ledge and shelf angles, channels and plates not attached to structural framing shall be steel, prime painted.
 - 3. Lintels shall be galvanized steel, as detailed and prime painted.

4. Overhead door frames and wall openings shall be steel channel sections, prime painted.
5. Fixed metal ladders shall be aluminum, mill finish, unless indicated otherwise on the Contract Drawings.
6. Aluminum structural shapes shall be mill finish.

3.2 QUALITY CONTROL

- A. Testing Agency: The Owner or Owner's Representative will engage a qualified independent testing and inspecting agency to perform special inspections as required by the Ohio Building Code.

END OF SECTION

SECTION 05 51 00

METAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following as shown on the Contract Drawings, complete including fabrication, shop finishing and installation:
 - 1. Industrial-type aluminum stairs with aluminum plank treads.

1.2 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements are specified herein.
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM A 325 - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
 - b. ASTM C 1107 – Packaged Dry Hydraulic Cement Grout (Non-shrink)
 - 2. American Welding Society (AWS)
 - a. AWS D1.2: Structural Welding Code – Aluminum
 - 3. National Association of Architectural Metal Manufacturers
 - a. NAAMM AMP 510: Metal Stairs Manual
 - b. NAAMM MBG 531: Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Stairs: Provide metal stairs capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
 - 1. Uniform Load: 100 lbf/sq. ft.
 - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 - 5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.
- B. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Component Importance Factor is 1.5.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Arrange for metal stairs specified in this Section to be fabricated and installed by the same firm.

- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal stairs that are similar to those indicated for this Project in material, design, and extent.
- C. Fabricator Qualifications: A firm experienced in producing metal stairs similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code – Aluminum". Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved.

1.5 SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for aluminum stairs. Include plans, elevations, sections, and details of metal stairs and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
 - 1. For installed products indicated to comply with design loads, include structural calculations and data signed and sealed by the licensed professional engineer responsible for their preparation. The Contractor shall pay for all costs associated with engineering costs.
- B. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.6 COORDINATION

- A. Coordinate installation of anchorages for aluminum stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.7 STORAGE AND PROTECTION

- A. Store members off ground and protect members and package materials from erosion and deterioration.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Project include, but are not limited to, the following:

1. Karnel, Inc.
2. Val-Fab, inc.
3. Ohio Gratings, Inc.

2.2 FASTENERS

- A. Provide fasteners of non-magnetic, stainless steel that is compatible with aluminum gratings and other components.

2.3 FABRICATION, GENERAL

- A. Form from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Shear and punch metals cleanly and accurately. Remove sharp or rough areas on exposed traffic surfaces.
- B. Finish exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated.
- C. Weld connections to comply with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Weld exposed corners and seams continuously unless otherwise indicated.
 5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 3 welds: partially dressed weld with spatter removed.
- D. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchorage devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
- E. Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for re-assembly and coordinated installation.

2.4 ALUMINUM-FRAMED STAIRS

- A. Stair Framing: Fabricate stringers of aluminum channels, plates, or a combination of both, as indicated. Provide closures for exposed ends of stringers. Construct platforms of aluminum channel headers and miscellaneous framing members as indicated. Bolt or weld headers to stringers; bolt or weld framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.

2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal stairs after assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
- E. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

3.2 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.
- B. Set aluminum stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use nonmetallic, non-shrink grout unless otherwise indicated.
- C. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

END OF SECTION

SECTION 05 52 13

PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following as shown on the Contract Drawings, complete including fabrication, shop finishing and installation.
 - 1. Aluminum pipe and tube railings.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements are specified herein.
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM A 325 - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - b. ASTM C 1107 - Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
 - 2. American Welding Society (AWS)
 - 3. Federal Specification
 - a. FS TT-P-664D - Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Compliant.
 - 4. National Association of Architectural Metal Manufacturers
 - a. Metal Finishes Manual for Architectural and Metal Products.
 - 5. Steel Structures Painting Council (SSPC)
 - 6. Occupational Safety and Health Administration (OSHA), Department of Labor
 - a. Code of Federal Regulations (CFR) 29, Part 1910 – Occupational Safety and Health Standards.

1.4 PERFORMANCE REQUIREMENTS

- A. All railings shall be in accordance with applicable OSHA regulations.
- B. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified, registered professional engineer licensed in the State of Ohio, using performance requirements and design criteria indicated.
- C. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.

- D. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- F. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.5 QUALITY ASSURANCE

- A. Obtain each type of handrail and railing through one source from a single manufacturer.
- B. Welding Qualifications: Quality procedures and personnel according to the following:
1. AWS D1.2, "Structural Welding Code – Aluminum"

1.6 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following shall also be submitted.
1. Shop Drawings indicating fabrication and installation of handrails and railings. Include plans, elevations, sections, component details, and attachments to other Work.
 - a. Indicate welded connection using standard AWS A2.0 welding symbols. Indicate net weld lengths.
 - b. Welding certificates.
 2. Grout, anchoring cement, and paint products.
 3. Engineering calculations prepared, stamped and signed by a qualified, registered professional engineer licensed in the State of Ohio.

1.7 STORAGE

- A. Store handrails and railings in a dry, well-ventilated, away from uncured concrete and masonry and protected from weather, moisture, soiling, abrasion extreme temperature and humidity.

1.8 PROJECT CONDITIONS

- A. Where handrails and railing systems are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.9 COORDINATION AND SCHEDULING

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Aluminum Pipe and Tube Railings:
 - a. ATR Technologies, Inc.
 - b. Blum, Julius & Co., Inc.
 - c. Braun, J. G., Company; a division of the Wagner Companies.
 - d. CraneVeyor Corp.
 - e. Hollaender Manufacturing Company.
 - f. Kee Industrial Products, Inc.
 - g. Moultrie Manufacturing Company.
 - h. Pisor Industries, Inc.
 - i. Sterling Dula Architectural Products, Inc.; Div. of Kane Manufacturing.
 - j. Superior Aluminum Products, Inc.
 - k. Thompson Fabricating, LLC.

- l. Tri Tech, Inc.
- m. Tubular Specialties Manufacturing, Inc.
- n. Tuttle Railing Systems; Div. of Tuttle Aluminum & Bronze, Inc.
- o. Wagner, R & B, Inc.; a division of the Wagner Companies.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.3 ALUMINUM

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
- B. Extruded Bars and Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
- C. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
 - 1. Rails: Provide nominal 1.5" diameter (1.9" actual outer diameter), schedule 40 pipe, unless otherwise indicated.
 - 2. Posts: Provide nominal 1.5" diameter (1.9" actual outer diameter), schedule 80 pipe, unless otherwise indicated.
- D. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M), Alloy 6063-T832.
- E. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
- F. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
- G. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.4 FASTENERS

- A. General: Provide the following:
 - 1. Aluminum Railings: Type 316 stainless-steel fasteners.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

2. Provide Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.
3. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
 1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- C. Non-shrink, Non-metallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- D. Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with either welded or non-welded connections unless otherwise indicated.
- H. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- I. Non-welded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- J. Form changes in direction as follows:
 - a. By bending or by inserting prefabricated elbow fittings.
- K. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- L. Close exposed ends of railing members with prefabricated end fittings.
- M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
- N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- P. For railing posts set in concrete, provide stainless-steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.
- Q. For removable railing posts, fabricate slip-fit sockets from stainless-steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.

- R. Expanded-Metal Infill Panels: Fabricate infill panels from expanded metal made from same metal as railings in which they are installed.
 - 1. Edge panels with U-shaped channels made from metal sheet, of same metal as expanded metal and not less than 0.043 inch thick.
- S. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).
- C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Non-welded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.4 ANCHORING POSTS

- A.
 - Anchor posts to surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.
 - B. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ADJUSTING AND CLEANING

- A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

3.6 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

3.7 QUALITY CONTROL

- A. Testing Agency: The Owner or Owner's Representative will engage a qualified independent testing and inspecting agency to perform special inspections as required by the 2011 Ohio Building Code.

END OF SECTION

SECTION 05 53 00

METAL GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Aluminum plank gratings.
 - 2. Aluminum frames and supports for gratings.

1.2 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements are specified herein:
 - 1. National Association of Architectural Metal Manufacturer's (NAAMM)
 - a. NAAMM MBG 531 - Metal Bar Grating Manual for Steel, Stainless Steel and Aluminum Gratings and Stair Treads.
 - b. Metal Finishes Manual for Architectural and Metal Products
 - 2. American Welding Society (AWS)
 - a. ASW D1.2 - Structural Welding Code – Aluminum
 - 3. American Society for Testing and Materials (ASTM)
 - a. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate
 - b. ASTM B221 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

1.3 QUALITY ASSURANCE

- A. Fabricator shall be experienced in producing plank gratings (not less than 10 years of documented experience) similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Metal Bar Grating Standards: Comply with applicable requirements, including fabrication tolerances, of the following:
 - 1. Non-Heavy-Duty Metal Bar Gratings: Comply with NAAMM MBG 531, "Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads."
 - 2. Heavy Duty Metal Bar Gratings: Comply with NAAMM MBG 532, "Heavy Duty Metal Bar Grating Manual for Structural Carbon Steel and Stainless Steel".
- C. Comply with applicable provisions of AWS D1.2 "Structural Welding Code – Aluminum".
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions:
 - 1. Product Data
 - a. Aluminum plank gratings.
 - b. Anchorage devices for plank gratings.
 - 2. Shop Drawings detailing fabrication and erection of gratings. Include plans, elevations, sections, and details of connections. Show areas of fixed and removable sections, anchorage, accessory items, and load tables. Provide templates for anchors and bolts specified for installation under other Sections.
 - 3. Welding Certificates: Copies of certificates for welding procedures and personnel.
 - 4. Samples of plank grating and anchorage system shall be submitted for approval.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements prior to fabrication.

1.6 COORDINATION

- A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 FERROUS METALS

- A. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 316.
- B. Stainless-Steel Bars and Shapes: ASTM A 276, Type 316.

2.2 ALUMINUM

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer for type of use indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
- B. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), alloys as follows:
 - 1. 6063-T6, for planks and banding.
- C. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 5052-H32.

2.3 FASTENERS

- A. General: Provide Type 316 stainless-steel fasteners.

- B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

2.6 METAL BAR GRATINGS

- A. Design Criteria: Grating products shall be designed and manufactured to meet the live load conditions of 100 lbs/ Sq Ft with maximum deflection of 1/4" for the clear spans shown on the drawings. Plank depth shall be as shown on the contract drawings or as recommended by the manufacturer to meet the loading requirements, clear span conditions and maximum deflections specified.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. IKG Industries; a division of Harsco Corporation.
 - 2. Ohio Gratings, Inc.
 - 3. Klemp. Corp
- C. Unpunched Aluminum Plank Grating: Unpunched, heavy duty, six inch wide, extruded aluminum plank with support bars spaced 1.2" on center, fabricated with banding into panels of standard width to fill areas shown on the drawings.

1. Plank Depth: As indicated in the Contract Drawings. If not identified, depth shall be based on loading requirements and clear span.
 2. Traffic Surface: Striated with 90 degree cross cut $\frac{3}{4}$ " on center for slip resistance.
 3. Aluminum Finish: Mill finish
- D. Punched Aluminum Plank Grating: Diagonal (ADA) punched, heavy duty, six inch wide, extruded aluminum plank with support bars spaced 1.2" on center, fabricated with banding into panels of standard width to fill areas shown on the drawings.
1. Plank Depth: As indicated in the Contract Drawings. If not identified, depth shall be based on loading requirements and clear span.
 2. Traffic Surface: Aluminum Titanium alloy wire with discrete particles that is thermally applied. Level surfaces shall have a minimum coefficient of friction of 0.60 and inclined surfaces shall have a coefficient of friction of 0.80.
 3. Punch Pattern: Diagonal (45 Deg) punched slotted holes on 0.75" centers along the span. Five rows per 6" wide plank section. To provide minimum open area of 15%.
 4. Aluminum Finish: Mill finish
- E. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
 2. Furnish stainless steel self-drilling fasteners with washers for securing grating to supports.
- F. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
- G. Do not notch bearing bars at supports to maintain elevation.

2.7 GRATING FRAMES AND SUPPORTS

- A. Frames and Supports for Aluminum Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
1. Unless otherwise indicated, fabricate from aluminum.
 2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of aluminum straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Perform all cutting and fitting required for installation. Grating shall be placed such that cross bars align.
 - 2. Wherever grating is pierced by pipes, ducts and structural members, cut openings neatly and accurately to size and weld a rectangular band bar of the same height and material as bearing bars.
 - 3. Cutouts for circular obstructions are to be at least 2 inches larger in diameter than the obstruction. Cutouts for all piping 4 inches or less shall be made in the field.
 - 4. All rectangular cutouts are to be made to the next bearing bar beyond the penetration with a clearance not to exceed bearing bar spacing.
 - 5. Utilize standard panel widths wherever possible.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
- D. Fit exposed connections accurately together to form hairline joints.
 - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

- A. General: Install gratings to comply with recommendations of referenced grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

- B. Attach removable units to supporting members with type and size of fasteners recommended by grating manufacturer for type of installation conditions shown.
- C. Attach non-removable units to supporting framing using welded anchor blocks and stainless steel, self-tapping screws.

END OF SECTION

SECTION 06 10 53

MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Skylight bases and support curbs.
2. Wood blocking, cants, and nailers.
3. Plywood backing panels.

1.2 DEFINITIONS

- A. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
- B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
1. NeLMA: Northeastern Lumber Manufacturers' Association.
 2. NLGA: National Lumber Grades Authority.
 3. SPIB: The Southern Pine Inspection Bureau.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Powder-actuated fasteners.
5. Expansion anchors.
6. Metal framing anchors.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
 - 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 - 4. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
 - 1. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 - 4. Design Value Adjustment Factors: Treated lumber shall be tested according ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- E. Application: Treat items indicated on Drawings, and the following:
 - 1. Concealed blocking.
 - 2. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Skylight bases and support curbs.
 - 4. Cants.
 - 5. Grounds.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber

- C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
 - 1. Eastern softwoods, No. 2 Common grade; NELMA.
 - 2. Northern species, No. 2 Common grade; NLGA.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening to Metal Framing: ASTM C 954, length as recommended by screw manufacturer for material being fastened.
- F. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
- G. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when

installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

2.7 MISCELLANEOUS MATERIALS

- A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate[**furring**,] nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- C. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- E. Do not splice structural members between supports unless otherwise indicated.
- F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
- G. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere

with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

- H. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- I. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- J. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.3 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

SECTION 06 82 00

GLASS FIBER REINFORCED PLASTIC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 46 61 41 – Disc Cloth Filters

1.2 SUMMARY

- A. This section covers furnishing all labor, equipment, and materials required to fabricate and install all fiberglass gratings and stairway treads, handrails, landings, and pump stands including all supporting angles, anchors, and incidental fastenings where shown on the Drawings or specified herein.

1.3 QUALITY ASSURANCE

A. GENERAL

- 1. The Contractors shall be responsible for ensuring that all equipment installed is properly connected to other related equipment for proper functioning of the plant.
- 2. Products included within this Specification shall be designed by a professional structural engineer licensed in the State of Ohio with experience in the design of this work.

B. WARRANTY

- 1. The Contractor shall provide from the equipment Manufacturer an extended warranty for a period of 12 months after acceptance of equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event that the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

C. MANUFACTURER'S QUALIFICATIONS

- 1. The Manufacturer of work of this section shall have five (5) years minimum proven experience in such work and shall have satisfactorily completed three (3) jobs of similar size and type within the last five (5) years

2. Substitutions for all work of this section from Manufacturers not complying with the specified experience period shall include the following:
 - a. Special guarantees and warranties
 - 1) Period: 5 years
 - 2) Manufacturer's special guarantees and warranties.
 - 3) Contractor's and Installer's special guarantees and warranties.
 - b. Bond or cash deposit equal to 100% of the equipment cost guaranteeing compliance of the above specified special guarantees and warranties.

1.4 SUBMITTALS

A. SHOP DRAWINGS AND ENGINEERING DATA

1. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:
 - a. All structural design calculations shall be prepared by the Manufacturer and sealed by a professional engineer registered in the State of Ohio. All work shall be fabricated and erected in accordance with fabricator/erector drawings.
 - b. Manufacturer's literature, illustrations, specification, and engineering data including total weight, structural loads at supports, and connection details.
 - c. Drawings shall show dimensions, overall arrangement, finishes, and materials of construction.
 - d. Show construction, assembly, fastening requirements, dimensions, and locations of custom openings. Contractor must field verify dimensions and elevations prior to shop drawing submittal.

1.5 REFERENCES

- A. ASTM E 84, Surface Burning Characteristics of Building Materials

1.6 STORAGE AND PROTECTION

- A. Store and protect the glass fiber reinforced plastic products in accordance with the requirements of Division 01.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. The equipment furnished under this section shall be equal to that provided by the following Manufacturers:
1. Strongwell.
 2. American Grating, Inc.

2.2 SYSTEM DESCRIPTION

A. DESIGN CRITERIA

1. Fiberglass grating shall be designed for an extreme fiber stress in bending of not more than 4,000 psi and a deflection of not more than 1/300 of the span length or 0.25 inch, whichever is less, under a uniform live load of 150 pounds per square foot.
2. The depth of the main bearing bars shall not be less than 1½ inches, and the clear spacing between main bearing bars shall not be less than 1 inch.
3. Fiberglass grating shall not be used for spans exceeding 4 feet, unless otherwise shown.

B. SYSTEM PERFORMANCE REQUIREMENTS

1. Structural Performance. Design, engineer, fabricate, and install the following fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each fabrication.
 - a. Top Rail of Handrail Systems: Capable of withstanding the following loads applied as indicated:
 - 1) Concentrated load of 200 pounds applied at any point non-concurrently, vertically downward, or horizontally.
 - 2) Uniform load of 100 pounds per linear foot applied vertically and concurrently with a uniform load of 50 lbs/ft applied horizontally.
 - 3) Concentrated loads in Item i need not be assumed to act concurrently with the uniform loads in Item ii.
 - b. Handrails Not Serving as Top Rails: Capable of withstanding the following loads applied as indicated:

- 1) Concentrated load of 200 pounds applied at any point nonconcurrently, vertically downward, or horizontally.
 - 2) Uniform load of 50 pounds per linear foot applied nonconcurrently, vertically downward, or horizontally.
 - 3) Concentrated loads in Item i need not be assumed to act concurrently with the uniform loads in Item ii.
- c. Stair Treads: Capable of withstanding a uniform load of 100 pounds per square foot or a concentrated load of 300 pounds on an area of 4 square inches located in the center of the tread, whichever produces the greater stress.
 - d. Stair Platforms: Capable of withstanding a uniform load of 100 pounds per square foot.
 - e. Floor Gratings: Capable of withstanding a uniform load of 150 pounds per square foot or a concentrated load of 300 pounds per foot of grating width, whichever produces the greater stress. No grating shall be installed which deflects more than 1/300th of span length or ¼ inch, whichever is less, under a uniform load of 150 pounds per square foot.
 - f. Roughing Filter Gratings: Capable of withstanding a uniform load of 150 pounds per square foot or a concentrated load of 300 pounds per foot of grating width, whichever produces the greater stress. No grating shall be installed which deflects more than 1/300th of span length or ¼ inch, whichever is less, under a uniform load of 150 pounds per square foot.

2.3 FIBERGLASS GRATINGS

- A. Fiberglass gratings shall be pultruded or molded of solid, I-shaped or rectangular main bars of fiberglass reinforced polyester resin. Resin shall be resistant to chemicals, aging, impact, sunlight, and heat, and have a flame spread classification of less than 25 in accordance with ASTM E 84. Grating shall be yellow in color and furnished with a long-wearing, non-skid grit top surface. Bars shall be smooth and uniform with no evidence of interlaminar voids, porosity, resin rich or resin starved areas.
- B. The gratings shall be of the type that can be made in panels of the widths and lengths appropriate to the openings shown on the Drawings, and no gratings will be accepted which require individual panels to be made up by binding narrow panels together. Panels shall be fabricated in a size that is easily handled. After installation, there shall not be more than ¼-inch clearance between sides of adjacent panels. Grating panels shall be reversible.
- C. The top surface of all bars shall be flush and all gratings shall lie flat with no tendency to rock when installed. Cross bars and edge bars of adjacent panels shall align for neatness. All main bearing bars shall be parallel.

- D. Securely anchor grating panels in place with stainless steel "J" bolts or aluminum saddle or hook clamps. Galvanized hardware shall not be acceptable.
- E. Main bearing bars shall be supported by fiberglass angle as shown on the Drawings or of appropriate size and thickness to position the top of the grating flush with the adjoining floor. There shall not be more than 1/4-inch clearance between the ends of the grating panels and the inside vertical face of the shelf angle.
- F. All surfaces shall be sound, smooth, clean, and free from defects. Completed sections shall be level and true so as to rest firmly on the bearing angles along the entire contact surface. Openings, where required, shall be neatly and accurately made to the dimensions required as shown on the Drawings. Poorly fitted or damaged grating shall be replaced. Where pipe or other items penetrate gratings, a joint centered on the penetration shall be provided to permit the grating to be removed without disturbing the pipe.
- G. Openings to be covered with grating shall be bound on all four sides with a continuous shelf angle frame having integral corners and sufficient strap anchors attached for anchorage into the concrete, unless otherwise shown.
- H. Furnish additional cross members to provide a seating surface where changes in channel direction, openings for gates, ends of grating runs, etc., prohibit adequate support for grating.

2.4 PREFABRICATED GRATING TREADS

- A. Fabricate from 1½-inch I-bar pultruded or molded grating to provide a tread width as shown on the Drawings within a tolerance of $\pm 1/4$ inch.
- B. Tread length to be as shown on the Drawings.
- C. Tread to incorporate a slip resistant grit top nosing.
- D. Mount treads to stringers with stainless steel bolts sized in accordance with the tread manufacturer's recommendations.

2.5 RAILINGS AND HANDRAILS

- A. General. Fabricate railings and handrails to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness, post spacings, and anchorage, but not less than that required to support structural loads.
- B. Finish. Coating per Section 9, Safety Yellow, unless otherwise indicated.
- C. Interconnect railing and handrail members by fully bonding with epoxy adhesive and completing connection with a solid concealed fiberglass plug, unless otherwise indicated.

- D. Provide slip joints to facilitate removal of pipe railing at all intersections, changes in direction, or at intervals not to exceed 25 feet in straight runs of railing. The slip joint shall be designed and constructed to provide strength equivalent to a straight section of pipe.
- E. Form changes in direction of railing members as follows:
 - 1. By insertion of prefabricated elbow fittings.
 - 2. By mitering at elbow bends.
 - 3. By any method indicated above, applicable to change of direction involved.
- F. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.
- G. Close exposed ends by use of prefabricated fittings, except where clearance of end of pipe and adjoining wall surface is $\frac{1}{4}$ inch or less.
- H. Toe Boards. Provide toe boards at railings around openings and at the edge of open-sided floors and platforms. Fabricate to dimensions and details indicated, or if not indicated, use 4 inches high x $\frac{1}{4}$ inch plate fastened to, and centered between, each railing post.
- I. Brackets, Flanges, Fittings, and Anchors. Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnections of pipe and attachment of railings and handrails to other work. Furnish inserts and other anchorage devices for connecting railings and handrails to concrete or masonry work.
 - 1. For surface mounted railing posts, provide prefabricated fiberglass mounting brackets with stainless steel anchors.
 - 2. For removable railing posts, provide socket covers designed and fabricated to resist accidental dislodgement.
- J. Provide guard chains across all railing openings where shown, specified, or required. Chain links shall be $\frac{1}{4}$ -inch stainless steel of welded construction, 12 links to the foot. One end shall be connected to a $\frac{1}{4}$ -inch stainless steel eye bolt in the stanchion and the other end shall be connected by means of a heavy, stainless steel swivel eye snap hook to a similar eye bolt in the opposite stanchion.

2.6 FRAMED STAIRS

- A. General. Construct stairs to conform to sizes and arrangements indicated. Join pieces together by bolting, unless otherwise indicated. Provide complete stair assemblies, including framing, hangers, columns, railings, newels, balusters, struts, clips, brackets, bearing plates, and other components necessary for the

support of stairs and platforms, and as required to anchor and contain the stairs on the supporting structure.

1. Fabricate treads and platforms of exterior stairs to accommodate slopes to drain in finished traffic surfaces.
- B. Stair Framing. Fabricate stringers of fiberglass channels as indicated. Construct platforms of fiberglass channel headers and miscellaneous framing members as indicated. Bolt headers to strings, newels, and framing members to strings and headers. Fabricate and join so that bolts do not appear on finish surfaces.
- C. Floor Grating Treads and Platforms. Comply with applicable requirements specified elsewhere in this section for grating.
- D. Fabricate grating treads with nosing on one edge and with angle or plate carrier at each end for stringer connections. Secure treads to stringers with stainless steel bolts.
- E. Fabricate grating platforms with nosing matching that on grating treads at all landings. Provide toe plates at open-sided edges of grating platform. Secure grating to platform frame with stainless steel clips and bolts.
- F. Stair Railings and Handrails. Comply with applicable requirements specified elsewhere in this section for railings and handrails.

2.7 ROUGHING FILTER GRATINGS

- A. Roughing filter gratings shall be molded of solid rectangular main bars of fiberglass reinforced polyester resin. Resin shall be resistant to chemicals, aging, impact, sunlight, and heat, and have a flame spread classification of less than 25 in accordance with ASTM E 84. Grating shall be furnished with a meniscus top surface. Bars shall be smooth and uniform with no evidence of interlaminar voids, porosity, resin rich or resin starved areas.
- B. The gratings shall be 1.5-inch thick minimum with 1½-inch by 1½-inch openings. Panels shall be fabricated in a size that is easily handled. After installation, there shall not be more than ¼-inch clearance between sides of adjacent panels.
- C. The top surface of all bars shall be flush and all gratings shall lie flat with no tendency to rock when installed. Cross bars and edge bars of adjacent panels shall align for neatness. All main bearing bars shall be parallel.
- D. Poorly fitted or damaged grating shall be replaced. Where pipe or other items penetrate gratings, a joint centered on the penetration shall be provided to permit the grating to be removed without disturbing the pipe.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
- B. Center nosings on tread widths with noses flush with riser faces and tread surfaces.
- C. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.2 FABRICATION, GENERAL

- A. Form fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures due to both solar heat gain and nighttime sky heat loss.
 - 1. Temperature Change (Range): 100° F (55.5° C).
- D. Saw cut and drill cleanly and accurately. Treat all exposed edges with epoxy to protect fiberglass.
- E. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Treat with epoxy to protect fiberglass.
- F. Remove sharp or rough areas on exposed traffic surfaces.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- H. Provide for anchorage of type indicated. Coordinate with supporting structures. Fabricate and space anchoring devices to provide adequate support for intended use.

- I. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- J. Cut, reinforce, and drill as indicated to receive finish hardware, screws, and similar items.
- K. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

3.3 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction. Provide anchorage devices and fasteners where necessary for securing miscellaneous fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- B. Cutting, Fitting, and Placement. Perform cutting, drilling, and fitting required for installation of miscellaneous fabrications. Set fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Expansion Anchors. Comply with anchor adhesive manufacturer's recommendations for:
 - 1. Location, spacing, depth of embedment, and installation of anchor.
 - 2. Drilling, cleaning, and preparation of holes to receive anchors.

3.4 SETTING LOOSE PLATES

- A. Clean concrete and masonry bearing surfaces of any bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
- B. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
 - 1. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 INSTALLATION OF PIPE RAILINGS AND HANDRAILS

- A. Adjust railings prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated, or if not indicated, as required by design loadings. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:
 - 1. Anchor posts by means of bolted side plates anchored into concrete.
 - 2. Install removable railing sections where indicated in slip-fit sockets attached to concrete. Accurately locate sockets to match post spacing.
- B. Secure handrails to wall with wall brackets and end fittings. Provide bracket with not less than 1½-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated, or if not indicated, at spacing required to support structural loads. Secure wall brackets and wall return fittings to building construction as follows:
 - 1. Use type of bracket with pre-drilled hole for exposed bolt anchorage.
 - 2. For concrete and masonry anchorage, use stainless steel epoxy set anchors.

3.6 INSTALLATION OF GRATINGS

- A. Install gratings in accordance with the manufacturer's recommendations and instructions.
- B. Gratings shall have no tendency to shift or rock and shall not exhibit excessive deflection under normal foot traffic.
- C. Protect fiberglass gratings during construction by a minimum 1/4-inch plywood cover.

3.7 SPARE PARTS

- A. NONE

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SECTION 06 85 00
COMPOSITE COVERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The work covered by this Section shall include the furnishing of all labor and materials to complete the equipment fabrication and installation of two (2) new influent screw pump covers, as shown on the Drawings. Each unit shall consist of channels, hatches, support beams, hold-down angles, assembly hardware and all other appurtenances necessary to provide a complete installation for satisfactory operation. Coordinate the size of the openings within each cover with the Drawings.

1.3 QUALITY ASSURANCE

A. GENERAL

- 1. The Contractor shall be responsible for ensuring that all equipment installed is properly connected to other related equipment for proper functioning of the Plant.

B. WARRANTY

- 1. The Contractor shall provide from the equipment Manufacturer an extended warranty for a period of 12 months after acceptance of equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event that the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

C. MANUFACTURER'S QUALIFICATIONS

- 1. Equipment and materials provided under this Section shall be the standard product in regular production by Manufacturers who shall have at least five years experience in the design and fabrication of the equipment as described herein, used for similar applications and shall have at least five installations of similar size and type within the last 5 years.

1.4 SUBMITTALS

A. SHOP DRAWINGS AND ENGINEERING DATA

- 1. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:

- a. All structural design calculations shall be prepared by the Manufacturer and sealed by a professional engineer registered in the State of Ohio. All work shall be fabricated and erected in accordance with fabricator/erector drawings.
 - b. Manufacturer's literature, illustrations, specification, and engineering data including total weight, structural loads at supports, and connection details.
 - c. Drawings shall show dimensions, overall arrangement of covers, interior and exterior finishes, and materials of construction.
 - d. Show construction, assembly, fastening requirements, dimensions, and locations of custom openings. Contractor must field verify dimensions and elevations prior to shop drawing submittal.
2. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor non-conformities, and detailed explanation of other non-conformities.

1.5 REFERENCES

- A. ASTM D-638, Standard Test Method for Tensile Properties of Plastics
- B. ASTM D-790, Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- C. ASTM D-1929, Standard Test Method for Ignition Properties of Plastics

1.6 STORAGE AND PROTECTION

- A. Store and protect the composite covers and accessories in accordance with the requirements of Division 01.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. The design has been based on equipment provided by the following Manufacturers:
 1. Enduro Composite Systems
 2. Strongwell
 3. Or approved equal

2.2 SYSTEM DESCRIPTION

A. GENERAL

1. The Manufacturer shall be responsible for the design of each flat cover and anchorage to the existing structures.
2. The design shall provide for expansion and contraction due to climatic change without damage to the cover.
3. The flat covers shall be designed to be self-supporting.
4. Dissimilar materials shall be separated from each other through the use of approved gaskets or coatings.

B. PERFORMANCE

1. Ultimate tensile strength (ASTM D-638): 30,000 psi min.
2. Ultimate flexural strength (ASTM D-790): 30,000 psi min.
3. Modulus of elasticity (ASTM D-790): 2.5×10^6 psi min.
4. Glass content: 50% min.
5. Linear coefficient of expansion: 5×10^{-6} inches/inch/°F .
ASTM D696 value measured in longitudinal direction.

C. DESIGN REQUIREMENTS:

1. A structure conforming to dimensions indicated on the Drawings, designed and fabricated as a panelized self-supporting (from the periphery) FRP cover structure.
2. The FRP cover structure shall be designed as clear-span and self-supporting from the existing periphery structure.
3. Individual cover structure panels shall be designed as interlocking and weather tight.
4. The FRP cover structure shall be designed to provide for expansion/contraction due to climatic change without damage to the cover.

D. DESIGN LOADINGS

1. The entire FRP cover structure shall be pre-engineered to the Ohio Building Code load requirements for the Project area and are the loads as specified in the following:

- a. Dead Load: Defined as the total weight of the cover structure and such other material attached to and supported by the cover structure.
 - b. Live Load: The minimum uniform load, assumed to act vertically upon the area of the cover upon a horizontal plane, shall have a value of 250 psf for horizontal surfaces and 45 psf for on inclines greater than 15°
 - c. Snow Load: The minimum uniform load value of 40 psf assumed to act vertically upon the area of the cover projected upon a horizontal plane.
 - d. Wind Load: Defined as having two (2) components:
 - 1) Horizontal velocity pressure of 10 psf multiplied by a shape factor acting upon the gross area of the vertical projection of the cover.
 - 2) Up-lift pressure, equal to one-half of the unit velocity pressure, which acts normal to the surface of cover.
 - 3) The cover design shall allow for wind from any direction.
2. Structural Members, Deflection Limits and Factors of Safety: FRP structural members shall be capable of supporting the design loads without the use of lateral bracing.
- a. Dead Load: Deflection limit of $L/360$, factor of safety = 5.
 - b. Dead + Live or Snow Load: Deflection limit of $L/180$, factor of safety = 2.1.
 - c. Wind minus Dead Load: Deflection limit of $L/180$, factor of safety = 1.88.
3. Deck Panels, Deflection Limits and Factors of Safety: FRP deck panels shall be capable of supporting a 300 lb. load over an effective area of 30 inches square.
- a. Deck plus Load: Deflection limit of $L/180$, factor of safety = 2.1.
 - b. Deck minus Load: Deflection limit of $L/60$, factor of safety = 1.88.
4. FRP Hatches, Deflection Limits and Factors of Safety: FRP hatch covers shall be capable of supporting a 275 lb. load over an effective area of 30 inches square.
5. Corrosion Resistance: The entire FRP cover structure shall be corrosion resistant and suitable for use in an environment of continuous exposure to wastewater (municipal sewage) and the hydrogen sulfide and mercaptans gases as generated in confined spaces.

2.3 SYSTEM COMPONENTS

A. RESINS

1. All resins used shall be chemical resistant isophthalic polyester resins containing UV stabilizers.
2. Resin shall be capable of withstanding continuous exposure to the environment present which includes hydrogen sulfide, mercaptans and UV light.
3. Resin shall be suitable for service in temperature range from -30 °F to +120 °F.
4. Covers shall meet ASTM E-84, Class I flame spread.

B. FIBERGLASS REINFORCEMENT

1. Fiberglass reinforcement shall consist of a combination of chopped strand mat and woven continuous roving and shall be treated with a finish compatible to the resin being used.
2. Glass content shall be 50% minimum by weight.
3. A Nexus veil shall be incorporated for additional chemical resistance.
4. Manufacturer
 - a. PPG
 - b. Owens Corning
 - c. Certainteed
 - d. Or approved equal

C. ANCHORAGE

1. Anchorage shall be with stainless steel expansion bolts in diameters as required by the Manufacturer.

2.4 FABRICATION

A. GENERAL

1. All panels shall be formed on suitable molds to ensure constant and accurate dimensions of the finished units or manufactured by pultrusion process.
2. Molds shall be so designed that each panel can be cast in one (1) piece without joining of members by either bonding or bolting.
3. The mold surface shall be coated with a heavy coat of pure resin before any glass is applied to ensure a resin rich inner surface for maximum chemical resistance.

4. One (1) layer of 1 oz. chopped strand mat shall be laid into a wet layer of resin and rolled to thoroughly wet and embed all fiber, followed immediately by alternating layers of 18 oz. woven roving and chopped mat to provide the total design thickness. Pultruded material laminated shall have a laminate schedule to meet or exceed project loads and deflections.
5. All layers shall be individually rolled to completely wet and embed all fibers on hand lay-up construction.
6. Following the hardening of the final layer of glass, a flush coat of pure resin shall be applied containing proper amounts of wax to ensure complete cure of the laminate on hand lay-up parts.
7. All layers shall contain pigment to produce a panel of the finish specified herein.
8. Hatches and other appurtenances as shown on the Drawings shall be pultruded or formed on separate suitable molds and fitted into proper openings which shall be cut in the finished panel.
9. All attachments shall be glassed from both the interior and exterior of the panel to ensure maximum strength if manufactured by the hand lay-up method.
10. Odor control system piping connections shall be provided as required by the Manufacturer of Section 40 05 13.76, FRP Ductwork.

2.5 FINISHES

- A. Opaque
- B. Color: Beige

2.6 HARDWARE

- A. All hardware to include fasteners, threaded rod, beam seats, etc. shall be type 316 stainless steel. No other material substitution will be allowed.

PART 3 – EXECUTION

3.1 INSTALLATION

A. GENERAL

1. Install equipment in accordance with Manufacturer's recommendations.

B. TOUCH-UP COATING

1. Touch up all damaged coating surfaces with compatible coating of identical color in such manner that there shall be no evidence of damage.

3.2 START-UP AND OPERATION

A. START-UP SERVICES

1. The Manufacturer shall furnish the services of a factory-trained field engineer specializing in this work to inspect and adjust the equipment after installation, and to instruct the Owner's personnel in its proper use.

3.3 SPARE PARTS

A. None

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SECTION 07 01 50.19

PREPARATION FOR REROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A Section Includes:
 - 1. Full tear-off of entire roof.
 - 2. Removal of base flashings.

1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.
- B. Full Roof Tear-Off: Removal of existing roofing system from steel deck or concrete fill.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

- A. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations. Submit before Work begins.

1.6 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately below reroofing area. Conduct re-roofing so Owner's operations are not disrupted. Provide Owner with not less than 72 hours' notice of activities that may affect Owner's operations.
 - 1. Coordinate work activities daily with Owner so Owner can place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.

2. Before working over structurally impaired areas of deck, notify Owner to evacuate occupants from below affected area. Verify that occupants below work area have been evacuated before proceeding with work over impaired deck area.
- B. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
- C. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
- D. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.

PART 2 - PRODUCTS

2.1 AUXILIARY REROOFING MATERIALS

- A. General: Use auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of new roofing system.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Shut off rooftop utilities and service piping before beginning the Work.
- B. Coordinate with Owner to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.
- C. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof-drain plugs specifically designed for this purpose. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

3.2 ROOF TEAR-OFF

- A. General: Notify Owner each day of extent of roof tear-off proposed for that day and obtain authorization to proceed.
- B. Full Roof Tear-Off: Remove existing roofing and other roofing system components down to the deck or concrete fill.

1. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen, unadhered felts, and wet felts.
2. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. (0.72 kg/sq. m) of asphalt is permitted to remain on steel decks.
3. Remove fasteners from deck or cut fasteners off slightly above deck surface.

3.3 DECK PREPARATION

- A. Inspect deck after tear-off of roofing system.
- B. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263 or by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if moisture condenses under plastic sheet or if asphalt test sample foams or can be easily and cleanly stripped after cooling.
- C. If broken or loose fasteners that secure deck panels to one another or to structure are observed, or if deck appears or feels inadequately attached, immediately notify Engineer. Do not proceed with installation until directed by Engineer.
- D. If deck surface is unsuitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Engineer. Do not proceed with installation until directed by Engineer.

3.4 BASE FLASHING REMOVAL

- A. Remove existing base flashings. Clean substrates of contaminants, such as asphalt, sheet materials, dirt, and debris.
- B. Do not damage metal counterflashings that are to remain. Replace metal counterflashings damaged during removal with counterflashings of same metal, weight or thickness, and finish.
- C. When directed by Engineer, replace parapet framing, wood blocking, curbs, and nailers.

3.5 DISPOSAL

- A. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Transport and legally dispose of demolished materials off Owner's property.

SECTION 07 21 00
THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Foam plastic board insulation under perimeter of slab on grade.
2. Foam plastic board insulation at perimeter foundation wall.
3. Mineral wool board insulation at cavity wall.
4. Mineral wool blanket insulation at miscellaneous locations.

B. Related Sections:

1. Section 061600 "Sheathing" for foam-plastic board sheathing over wood or steel framing.
2. Section 071326 "Self-Adhering Sheet Waterproofing" for insulated drainage panels installed with waterproofing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. Owens Corning.
 - d. Pactiv Building Products.
 - e. Or approved equal.
 - 2. Type IV, 1.60 lb/cu. ft., unless otherwise indicated.

2.2 MINERAL-WOOL BOARD INSULATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Roxul Inc. as basis of design.
 - 2. Fibrex Insulations Inc.

3. Isolatek International.
 4. Owens Corning.
 5. Thermafiber.
 6. Or approved equal.
- B. Mineral-Wool Board Insulation: ASTM C 612; faced on one side with foil-scrim or foil-scrim-polyethylene vapor retarder; with maximum flame-spread and smoke-developed indexes of 25 and 5, respectively, per ASTM E 84.
1. Nominal density of 4 lb/cu. ft., Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.3 MINERAL-WOOL BLANKET INSULATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Fibrex Insulations Inc.
 2. Owens Corning.
 3. Roxul Inc.
 4. Thermafiber.
 5. Or approved equal.
- B. Unfaced, Mineral-Wool Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

2.4 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
 - b. Gemco; Spindle Type.
 - c. Or approved equal.

2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.
- B. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. AGM Industries, Inc.; RC150.
 - b. AGM Industries, Inc.; SC150.
 - c. Gemco; Dome-Cap.
 - d. Gemco; R-150.
 - e. Or approved equal.
 2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap.
- C. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. AGM Industries, Inc.; TACTOO Adhesive.
 - b. Gemco; Tuff Bond Hanger Adhesive.
 - c. Or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF FOUNDATION PERIMETER AND UNDER-SLAB INSULATION

- A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 - 1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

3.4 INSTALLATION OF CAVITY-WALL INSULATION

- A. Mineral Wool Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

3.5 INSTALLATION OF INSULATION FOR MISCELLANEOUS LOCATIONS

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.

4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

3.6 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

SECTION 07 53 23

ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Adhered ethylene-propylene-diene-monomer (EPDM) roofing system.
2. Roof insulation.

1.2 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Verification: For the following products:
1. Sheet roofing, of color required.
 2. Walkway pads or rolls, of color required.

1.5 INFORMATIONAL SUBMITTALS

- A. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
- B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.
 - 2. Type: Total Roofing System, No Dollar Limit on labor and material.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain components including roof insulation and fasteners for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
- B. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
- D. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class C; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.3 EPDM ROOFING

- A. EPDM: ASTM D 4637, Type II, scrim or fabric internally reinforced, uniform, flexible EPDM sheet.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.

- c. GAF Materials Corporation.
 - d. Johns Manville.
 - e. Versico Incorporated.
 - f. Or approved equal.
- 2. Thickness: 60 mils (1.5 mm), nominal.
 - 3. Exposed Face Color: Black.

2.4 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, partially cured or cured, according to application.
- C. Protection Sheet: Epichlorohydrin or neoprene nonreinforced flexible sheet, 55- to 60-mil- (1.4- to 1.5-mm-) thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.
- D. Bonding Adhesive: Manufacturer's standard.
- E. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film.
- F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.
- G. Miscellaneous Accessories: Provide lap sealant, water cutoff mastic, metal termination bars, metal battens, pourable sealers, preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.5 SUBSTRATE BOARDS

- A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate panel to roof deck.

2.6 ROOF INSULATION

- A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
- B. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
- C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.7 INSULATION ACCESSORIES

- A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
- B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer.

2.8 ASPHALT MATERIALS

- A. Roofing Asphalt: ASTM D 312, Type III or Type IV.

2.9 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.

PART 3 - EXECUTION

3.1 ROOFING INSTALLATION, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.2 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Install tapered insulation under area of roofing to conform to slopes indicated.

- C. Minimum insulation thickness at roof drains shall be 2 inches. Provide an aged, average thermal value of R-24.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
 - 1. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
- E. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
 - 2. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
 - 3. Set each subsequent layer of insulation in insulation adhesive, firmly pressing and maintaining insulation in place.

3.3 ADHERED MEMBRANE ROOFING INSTALLATION

- A. Adhere roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
- B. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- C. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.
- D. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeters.
- E. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing terminations.
 - 1. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.
- F. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping roofing according to manufacturer's

written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing terminations.

- G. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.
- H. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal membrane roofing in place with clamping ring.

3.4 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.5 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.6 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Engineer and Owner.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

SECTION 07 71 00
ROOF SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Copings.
 - 2. Roof-edge flashings.
 - 3. Roof-edge drainage systems.
 - 4. Reglets and counterflashings.
- B. Related Sections:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Section 079220 "Exterior Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. FM Approvals' Listing: Manufacture and install copings and roof-edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. Identify materials with FM Approvals' markings.
- C. SPRI Wind Design Standard: Manufacture and install copings and roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:
 - 1. Design Pressure: As indicated on Drawings.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of

thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof specialties. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:
 1. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
 2. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.
 3. Details of termination points and assemblies, including fixed points.
 4. Details of special conditions.
- C. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.
- D. Samples for Verification: For copings, roof-edge flashings, roof-edge drainage systems, and reglets and counterflashings made from 12-inch lengths of full-size components including fasteners, cover joints, accessories, and attachments.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for copings and roof-edge flashings.
- B. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site.
 1. Meet with Owner, Engineer, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects roof specialties including installers of roofing materials and accessories.

2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

1.9 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EXPOSED METALS

- A. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
 1. Surface: Smooth, flat finish.
 2. Exposed High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

- a. Two-Coat Fluoropolymer: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.

2.2 CONCEALED METALS

- A. Aluminum Sheet: ASTM B 209, alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.
- B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
 1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
 2. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
 3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- C. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
- D. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- E. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.4 COPINGS

- A. Copings: Manufactured C-shape coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet, concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Engineerural Products Company.
 - b. ATAS International, Inc.
 - c. Cheney Flashing Company.
 - d. Hickman Company, W. P.
 - e. MM Systems Corporation.
 - f. Or approved equal.
2. Coping-Cap Material: Formed aluminum, 0.050 inch thick.
 - a. Finish: Two-coat fluoropolymer.
 - b. Color: As selected by Engineer from manufacturer's full range.
 3. Corners: Factory mitered and continuously welded.
 4. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.
 5. Snap-on-Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches wide, with integral cleats.

2.5 ROOF-EDGE FLASHINGS

- A. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet and a continuous formed- or extruded-aluminum anchor bar with integral drip-edge cleat to engage fascia cover. Provide matching corner units.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Engineerural Products Company.
 - b. ATAS International, Inc.
 - c. Cheney Flashing Company.
 - d. Hickman Company, W. P.
 - e. MM Systems Corporation.
 - f. Or approved equal.
 2. Profile: See drawings for configuration.
 3. Fascia Cover: Fabricated from the following exposed metal:

- a. Formed Aluminum: 0.050 inch thick.
 4. Corners: Factory mitered and continuously welded.
 5. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.
 6. Fascia Accessories: Fascia extenders with continuous hold-down cleats or Soffit trim.
- B. Aluminum Finish: Two-coat fluoropolymer.
1. Color: As selected by Engineer from manufacturer's full range.

2.6 ROOF-EDGE DRAINAGE SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Engineerural Products Company.
 2. ATAS International, Inc.
 3. Cheney Flashing Company.
 4. Hickman Company, W. P.
 5. MM Systems Corporation.
 6. Or approved equal.
- B. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
1. Fabricate from the following exposed metal:
 - a. Formed Aluminum: 0.040 inch (1.02 mm) thick.
 2. Gutter Profile: As indicated on drawings.
 3. Corners: Factory mitered and mechanically clinched and sealed watertight.
 4. Gutter Supports: Gutter brackets with finish matching the gutters.
 5. Gutter Accessories: Wire ball downspout strainer and flat ends.
- C. Downspouts: Plain rectangular complete with crimped-curve elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Formed Aluminum: 0.040 inch (1.02 mm) thick.
- D. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch- wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof.
 1. Fabricate from the following exposed metal:
 - a. Formed Aluminum: 0.032 inch thick.
- E. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout, exterior flange trim, and built-in overflow.
 1. Fabricate from the following exposed metal:
 - a. Formed Aluminum: 0.032 inch thick.
- F. Aluminum Finish: Two-coat fluoropolymer.
 1. Color: As selected by Engineer from manufacturer's full range.
- G. Sizing: [Addendum No. 2]
 1. All gutters to be 4"x5" rectangular, sloping at 1/8" per foot.
 2. All downspouts to be 3"x4" rectangular, except for the following location:
 - a. Southwest corner of the Solids/Dewatering building shall combine multiple 3"x4" downspouts into a vertical 4"x6" downspout.
 3. Downspouts running horizontally shall have a minimum slope of 1/2" per foot.

2.7 REGLETS AND COUNTERFLASHINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Cheney Flashing Company.
 2. Heckmann Building Products Inc.
 3. Hickman Company, W. P.
 4. Keystone Flashing Company, Inc.
 5. MM Systems Corporation.
 6. Or approved equal.

- B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
 - 1. Formed Aluminum: 0.050 inch thick.
 - 2. Stainless Steel: 0.025 inch thick.
 - 3. Corners: Factory mitered and continuously welded.
 - 4. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 - 5. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
- C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding 12 feet designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:
 - 1. Stainless Steel: 0.025 inch thick.
- D. Accessories:
 - 1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
 - 2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
- E. Aluminum Finish: Mill.
- F. Stainless-Steel Finish: No. 2B (bright, cold rolled, unpolished).

2.8 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Engineerural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.
 - 1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 - 3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 - 4. Torch cutting of roof specialties is not permitted.
 - 5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Coat concealed side of uncoated aluminum and stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 - 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
 - 1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise shown on Drawings.

2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that will penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.3 COPING INSTALLATION

- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor copings to meet performance requirements.
 1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's required spacing that meets performance requirements.

3.4 ROOF-EDGE FLASHING INSTALLATION

- A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.5 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

- A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
- B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 12 inches (305 mm) apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.
 1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion joint caps.
- C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.

- D. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
 - 1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
 - 2. Loosely lock front edge of scupper with conductor head.
 - 3. Seal or solder exterior wall scupper flanges into back of conductor head.
- E. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch below scupper discharge.

3.6 REGLET AND COUNTERFLASHING INSTALLATION

- A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.
- B. Embedded Reglets: See Section 033000 "Cast-in-Place Concrete" for installation of reglets.
- C. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches over top edge of base flashings.
- D. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.7 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

SECTION 07 72 00
ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Preformed flashing sleeves.

- B. Related Sections:

- 1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
 - 2. Section 077100 "Roof Specialties" for manufactured fasciae, copings, and counterflashing.

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Size and location of roof accessories specified in this Section.

2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.8 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 METAL MATERIALS

- A. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 coated.

1. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

2.2 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, thickness as indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Underlayment:
 1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
 2. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D 4397.
 3. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.
- F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
 1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

- H. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 PREFORMED FLASHING SLEEVES

- A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches high, with removable metal hood and slotted metal collar.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Custom Solution Roof and Metal Products.
 - b. Thaler Metal USA Inc.
 - c. Or approved equal.
 - 2. Metal: Aluminum sheet, 0.063 inch thick.
 - 3. Diameter: As indicated.
 - 4. Finish: Manufacturer's standard.
- B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Custom Solution Roof and Metal Products.
 - b. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
 - c. Thaler Metal USA Inc.
 - d. Or approved equal.
 - 2. Metal: Aluminum sheet, 0.063 inch thick.
 - 3. Height: Minimum 7 inches.
 - 4. Diameter: As indicated.
 - 5. Finish: Manufacturer's standard.

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Engineerural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
 - 1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
 - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene sheet.
 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Preformed Flashing-Sleeve Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions.
- D. Seal joints with butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions.
- B. Clean off excess sealants.
- C. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

SECTION 07 84 13

PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Related Sections:

1. Section 078446 "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
 - 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
 - b. Classification markings on penetration firestopping correspond to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
 - 3) FM Global in its "Building Materials Approval Guide."

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A/D Fire Protection Systems Inc.
 - 2. Grace Construction Products.
 - 3. Hilti, Inc.
 - 4. Johns Manville.
 - 5. 3M Fire Protection Products.
 - 6. Tremco, Inc.; Tremco Fire Protection Systems Group.
 - 7. USG Corporation.
 - 8. Or approved equal.

2.2 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
 - 1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls, and fire partitions.
 - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
 - 1. Horizontal assemblies include floors and ceiling membranes of roof/ceiling assemblies.

2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
 3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-wool-fiber or rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 2. Temporary forming materials.
 3. Substrate primers.
 4. Collars.
 5. Steel sleeves.

2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

- A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
- C. Install fill materials for firestopping by proven techniques to produce the following results:
1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so

labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Engineer will review mock-up of each type of installation of firestopping systems.
- B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.
- C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Where Intertek ETL SEMKO-listed systems are indicated, they refer to design numbers in Intertek ETL SEMKO's "Directory of Listed Building Products" under "Firestop Systems."

- C. Where FM Global-approved systems are indicated, they refer to design numbers listed in FM Global's "Building Materials Approval Guide" under "Wall and Floor Penetration Fire Stops."
- D. Firestopping with No Penetrating Items:
 - 1. UL-Classified Systems: (F,W,C)-(A,J,K,L)-(0001 thru 0999).
 - 2. Intertek ETL SEMKO-Listed Systems: As tested for type of penetration, type of construction, and rating required.
 - 3. FM Global-Approved Systems: As tested for type of penetration, type of construction, and rating required
 - 4. F-Rating: Match barrier rating.
 - 5. T-Rating: Match barrier rating.
 - 6. Type of Fill Materials: As required to achieve rating.
- E. Firestopping for Metallic Pipes, Conduit, or Tubing:
 - 1. UL-Classified Systems: (F,W,C)-(A,J,K,L)-(1001 thru 1999).
 - 2. Intertek ETL SEMKO-Listed Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
 - 3. FM Global-Approved Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
 - 4. F-Rating: Match barrier rating.
 - 5. T-Rating: Match barrier rating.
 - 6. Type of Fill Materials: As required to achieve rating.
- F. Firestopping for Nonmetallic Pipe, Conduit, or Tubing:
 - 1. UL-Classified Systems: (F,W,C)-(A,J,K,L)-(2001 thru 2999).
 - 2. Intertek ETL SEMKO-Listed Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
 - 3. FM Global-Approved Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
 - 4. F-Rating: Match barrier rating.
 - 5. T-Rating: Match barrier rating.
 - 6. Type of Fill Materials: As required to achieve rating.

G. Firestopping for Electrical Cables:

1. UL-Classified Systems: (F,W,C)-(A,J,K,L)-(3001 thru 3999).
2. Intertek ETL SEMKO-Listed Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
3. FM Global-Approved Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
4. F-Rating: Match barrier rating.
5. T-Rating: Match barrier rating.
6. Type of Fill Materials: As required to achieve rating.

H. Firestopping for Cable Trays with Electric Cables:

1. UL-Classified Systems: (W,C)-(J,K,L)-(4001 thru 4999).
2. Intertek ETL SEMKO-Listed Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
3. FM Global-Approved Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
4. F-Rating: Match barrier rating.
5. T-Rating: Match barrier rating.
6. Type of Fill Materials: As required to achieve rating.

I. Firestopping for Insulated Pipes:

1. UL-Classified Systems: (F,W,C)-(A,J,K,L)-(5001 thru 5999).
2. Intertek ETL SEMKO-Listed Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
3. FM Global-Approved Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
4. F-Rating: Match barrier rating.
5. T-Rating: Match barrier rating.
6. Type of Fill Materials: As required to achieve rating.

J. Firestopping for Miscellaneous Electrical Penetrants:

1. UL-Classified Systems: (F,W,C)-(A,J,K,L)-(6001 thru 6999).

2. Intertek ETL SEMKO-Listed Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
 3. FM Global-Approved Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
 4. F-Rating: Match barrier rating.
 5. T-Rating: Match barrier rating.
 6. Type of Fill Materials: As required to achieve rating.
- K. Firestopping for Miscellaneous Mechanical Penetrants:
1. UL-Classified Systems: (F,W,C)-(A,J,K,L)-(7001 thru 7999).
 2. Intertek ETL SEMKO-Listed Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
 3. FM Global-Approved Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
 4. F-Rating: Match barrier rating.
 5. T-Rating: Match barrier rating.
 6. Type of Fill Materials: As required to achieve rating.
- L. Firestopping for Groupings of Penetrants:
1. UL-Classified Systems: (F,W,C)-(A,J,K,L)-(8001 thru 8999).
 2. Intertek ETL SEMKO-Listed Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
 3. FM Global-Approved Systems: As tested for type of penetration, type of penetrating material, type of construction, and rating required.
 4. F-Rating: Match barrier rating.
 5. T-Rating: Match barrier rating.
 6. Type of Fill Materials: As required to achieve rating.

SECTION 07 84 46

FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Joints in or between fire-resistance-rated constructions.
- 2. Joints in smoke barriers.

- B. Related Sections:

- 1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.
 - 1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:
 - 1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:
 - a. Fire-resistive joint system products bear classification marking of qualified testing agency.
 - b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek ETL SEMKO in its "Directory of Listed Building Products."

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

- A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:
 - 1. Joints include those installed in or between fire-resistance-rated walls and roofs or roof/ceiling assemblies.
 - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
 - 3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A/D Fire Protection Systems Inc.
 - b. CEMCO.
 - c. Fire Trak Corp.
 - d. Grace Construction Products.
 - e. Hilti, Inc.
 - f. Johns Manville.
 - g. 3M Fire Protection Products.
 - h. Tremco, Inc.; Tremco Fire Protection Systems Group.
 - i. USG Corporation.
 - j. Or approved equal.
- C. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- D. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
 - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

- C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply fill materials so they contact and adhere to substrates formed by joints.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Engineer will review mock-up of each type of installation of fire-resistive joint system.
- B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.
- C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.

- B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

3.7 FIRE-RESISTIVE JOINT SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN .
- B. Where Intertek ETL SEMKO-listed systems are indicated, they refer to design numbers in Intertek ETL SEMKO's "Directory of Listed Building Products" under product category Expansion/Seismic Joints or Firestop Systems.
- C. Floor-to-Floor, Fire-Resistive Joint Systems:
 - 1. Available UL-Classified Systems: FF-D-(0000 thru 0999).
 - 2. Assembly Rating: 2 hour.
 - 3. Nominal Joint Width: As indicated.
 - 4. Movement Capabilities: Class I
- D. Wall-to-Wall, Fire-Resistive Joint Systems:
 - 1. Available UL-Classified Systems: WW-D-(0000 thru 0999)..
 - 2. Assembly Rating: Equal to wall rating.
 - 3. Nominal Joint Width: As indicated.
 - 4. Movement Capabilities: Class I
- E. Floor-to-Wall Fire-Resistive Joint Systems:
 - 1. Available UL-Classified Systems: FW-D-(0000 thru 0999).
 - 2. Assembly Rating: Equal to wall rating.
 - 3. Nominal Joint Width: As indicated.
 - 4. Movement Capabilities: Class I.
- F. Head-of-Wall, Fire-Resistive Joint Systems:
 - 1. Available UL-Classified Systems: HW-D-(0000 thru 0999)..
 - 2. Assembly Rating: Equal to wall rating.

3. Nominal Joint Width: As indicated.

4. Movement Capabilities: Class I

G. Bottom-of-Wall, Fire-Resistive Joint Systems:

1. UL-Classified Systems: BW-D- 0000-0999.

2. Assembly Rating: Equal to wall rating.

3. Nominal Joint Width: As indicated.

4. Movement Capabilities: Class I

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Latex joint sealants.
3. Acoustical joint sealants.
4. Industrial Polysulfide Joint Sealant

B. Related Sections:

1. Section 042000 "Unit Masonry" for masonry control and expansion joint fillers and gaskets.
2. Section 078446 "Fire-Resistive Joint Systems" for sealing joints in fire-resistance-rated construction.

1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Engineer.
2. Conduct field tests for each application indicated below:
 - a. Each kind of sealant and joint substrate indicated.
3. Notify Engineer seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
 - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and testing agency.
- B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
- D. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- E. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- F. Field-Adhesion Test Reports: For each sealant application tested.
- G. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
- C. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

- D. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.7 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 - 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 - 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- E. Colors of Exposed Joint Sealants: As selected by Engineer from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
- B. Single-Component, Nonsag, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use T.
- C. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

2.3 LATEX JOINT SEALANTS

- A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

2.4 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

2.5 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.6 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
 - b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or

deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

- a. Construction joints in cast-in-place concrete.
- b. Control and expansion joints in unit masonry.
- c. Joints between metal panels.
- d. Joints between different materials listed above.
- e. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
- f. Control and expansion joints in ceilings and other overhead surfaces.
- g. Other joints as indicated.

2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 50.

3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.

B. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:

- a. Isolation joints in cast-in-place concrete slabs.
- b. Control and expansion joints in tile flooring.
- c. Other joints as indicated.

2. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing.

3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

- a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Tile control and expansion joints.
 - d. Vertical joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
 - e. Perimeter joints between interior wall surfaces and frames of interior doors, windows and, elevator entrances.
 - f. Other joints as indicated.
 2. Joint Sealant: Latex.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Sealant Location:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated.
 2. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Location:
 - a. Acoustical joints where indicated.
 - b. Other joints as indicated.
 2. Joint Sealant: Acoustical.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range.

- F. Joint-Sealant Application: Chemical storage area in vertical surfaces and horizontal surfaces.
1. Joint Location:
 - a. Secondary Containment Chemical Resistant Lining area.
 2. Joint Sealant: Industrial Polysulfide.
 - a. Basis-of-Design: Thiokol 2235M
 3. Joint-Sealant Color: Gray
 4. Install per manufacturer's direction for chemicals used and joint configurations.

SECTION 08 16 13

FIBERGLASS DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work covered by this section consists of furnishing all labor, equipment, and material required to furnish and install all fiberglass doors and frames, and related work as described herein and/or shown on the Drawings.
- B. Related Sections. The following sections contain requirements that relate to this section:
 - 1. Section 04 2000, Unit Masonry
 - 2. Section 08 7100, Door Hardware
 - 3. Section 08 8100, Glass and Glazing

1.2 SUBMITTALS

- A. Submit complete shop drawings and engineering data in accordance with requirements described in Section 01 3323, Shop Drawings, Product Data, and Samples.
- B. Submittal drawings for approval shall be submitted prior to manufacture and will include the following information:
 - 1. Summary door schedule indicating the specific reference numbers as used on contract documents, with columns noting door type, frame type, size, handing, accessories and hardware.
 - 2. A drawing depicting front and rear door elevations showing internal reinforcement and hardware with bill of material for each door.
 - 3. Drawing showing dimensional location of each hardware item and size of each door.
 - 4. Individual part drawing and specifications for each hardware item and FRP part or product.
 - 5. Construction and mounting detail for each frame type including anchor types and spacing.
- C. Samples for Initial Color Selection. Submit samples of colors on 12-inch-long section of door member for approval by Engineer.

1.3 SHIPMENT, PROTECTION, AND CLEANING

- A. Shipment. All materials shall be delivered to the site in sealed, undamaged containers fully identified with the manufacturer's name, project number, tag location, door type, color, and weight. Store materials in original cartons, on edge in such a way to prevent falling or damage to face, corners, and edges.
- B. Protection. Protect doors and frames from damage during transportation and at the job site. Store at the site under cover on wood blocking or on suitable floors. After installation, protect doors and frames from damage during subsequent construction activity. Damaged work will be rejected and shall be replaced with new work.
- C. Cleaning. Upon completion, fiberglass surfaces of doors and frames that are factory finished shall be thoroughly cleaned and touched-up as recommended by the manufacturer.

1.4 WARRANTY

- A. Provide a warranty against defective or deficient products and workmanship in accordance with the requirements of Section 01 7836, Warranties and Bonds.
- B. Manufacturer shall unconditionally warranty its door for 10 years against failures due to corrosion from the specific environment named at time of purchase.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Doors shall be made of fiberglass reinforced plastic (FRP) using chemically proven resins to contaminants typically found in a wastewater facility environment. Doors shall be 1¾ inch thick and have an R-factor of 9. All mortises shall be molded in at the factory. The fiberglass content shall be a minimum of 25 percent by weight.
- B. Door plates shall be molded in one continuous piece. Construction of sheets shall consist of at least 15 mil (dry thickness) of gelcoat of the color specified, integrally molded with at least 3 layers of 1.5-ounce-per-square-foot fiberglass mat.
- C. Adequate reinforcing and compression members shall be used to accommodate surface hinges, closers, locksets, kickplates, push or pull plates. When engineering decisions dictate, mild steel is buried in the fiberglass matrix to provide enhanced screw holding power. In no case shall screws be anchored directly in the fiberglass matrix to provide holding for hinges, locks or closures, or any structured attachment. All voids between door plates shall be completely filled with material having a flame spread of 25 or less per ASTM E 84. When thru-bolting is to occur, a compression member is to be located which will provide memory resistance to the torquing of thru-bolts.
- D. All reinforcing resins shall achieve a flame spread of 25 or less per ASTM E 84 and shall be self-extinguishing per ASTM D 635.
- E. Window openings and louver opening shall be made such that no part of the inside of the door will be exposed to the environment prior to the installation of windows or louvers. Windows shall be glazed with a material specified in Section 08 8100, Glass and Glazing.

- F. Transoms shall be similar in construction, materials, thickness, and reinforcement in same manner to that of the door.
- G. Door frames shall be of all FRP construction with a nominal face width of 2 inches and an overall frame width of not less than 5½ inches. Frames may be assembled from fiberglass pultrusions of not less than 3/16 inch in thickness. The frame shall be integrally gelcoated to the specified color when molded. All miter cut joints shall be assembled by use of FRP clips and stainless steel fasteners. Frame, upon assembly shall be one piece in nature and rigid in construction.
- H. All hardware where applicable (locksets, hinges, closures, etc.) shall be installed at the door manufacturing plant. The manufacturer's warranty shall be included with the hardware installation.
- I. No aluminum or aluminum alloy shall be used in the construction of FRP doors.
- J. Doors shall be by Chem-Pruf, Corrim, Fib-R-Door, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install doors and frames in accordance with the manufacturer's instructions and applicable portions of Steel Door Institutes SDI-100.
- B. Install frames plumb and square. Securely attach the frame to the structure before removing spreader bars.
- C. Coordinate installation of glazing and louvers.
- D. The installer shall not cut or otherwise alter the integrity of the door to allow the door to fit the frame. Any alternations to the door will be performed at the manufacturer's factory.

SECTION 08 3113

FLOOR DOORS

PART 1 - GENERAL

1.1 SCOPE

- A. The work covered by this section consists of furnishing all labor, equipment, and materials required to furnish and install aluminum floor doors as shown on the Drawings and/or specified herein.

1.2 DESIGN CRITERIA

- A. Interior floor doors shall be designed for a live load of not less than 150 pounds per square foot at an extreme fiber stress in bending of not more than 33 percent of the minimum yield strength of the material.
- B. Exterior floor doors shall be designed for a live load of not less than 300 pounds per square foot at an extreme fiber stress in bending of not more than 33 percent of the minimum yield strength of material. Where called for on the Drawings, exterior floor doors shall be designed to support an H-20 wheel loading.

1.3 SHOP DRAWINGS AND ENGINEERING DATA

- A. Complete shop drawings and engineering data shall be submitted in accordance with the requirements of Section 01 3323, Shop Drawings, Product Data and Samples.

1.4 STORAGE AND PROTECTION

- A. Store and protect floor doors in accordance with the requirements of Section 01 6600, Storage and Protection.

1.5 GUARANTEE

- A. Provide a guarantee against defective materials and workmanship in accordance with the requirements of Section 01 7836, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 INTERIOR FLOOR DOORS

- A. Construct interior floor doors of aluminum with a diamond pattern tread or other acceptable raised nonslip surface.
- B. Frames shall be 1/4-inch extruded aluminum with built-in neoprene cushion and with strap anchors bolted to exterior or with extruded anchor flange.

- C. Door leaf shall be minimum ¼-inch aluminum diamond plate reinforced with aluminum stiffeners as required. Cast steel hinges shall be bolted to underside and pivot on torsion bars that counterbalance the door for easy operation. The door shall open to 90 degrees and lock automatically in that position. Provide a vinyl grip handle on the door interior to release and close cover with one hand. Doors shall be equipped with an outside flush lifting handle and hold back safety chains.
- D. Factory finish for aluminum floor doors shall be lacquer with bituminous coating applied to all surfaces in contact with concrete. Steel hardware shall be galvanized or cadmium plated.
- E. The two (2) aluminum floor doors within the PEPS Building shall have OSHA-compliant aluminum falls protection grating.
- F. The aluminum floor door directly above the telescoping valve within the PEPS Building shall also have an 8-inch x 8-inch hinged panel located within the cover of the floor door. This hinged panel shall be accessible and able to open without opening the floor door itself.
- G. Interior floor doors shall be single-leaf or double-leaf as shown on the Drawings and shall be manufactured by Bilco, Babcock-Davis, or equal.

2.2 EXTERIOR FLOOR DOORS

- A. Construct exterior floor doors of aluminum with a diamond pattern tread or other acceptable raised nonslip surface. They shall be watertight and of the sizes shown on the Drawings.
- B. Frames shall be ¼-inch extruded aluminum formed to a channel gutter approximately 3 inches wide, with an anchor flange around the perimeter. Containing frames shall be neatly made. Attach sufficient anchors to the frames for proper anchoring into the concrete. Clear opening must not be reduced. Provide a 1½-inch drainage coupling for plumber's connection in the low corner of the channel frame, located as indicated on the Drawings.
- C. Doors shall be provided with a minimum of two heavy forged bronze hinges with stainless steel pins. Doors shall be equipped with an outside flush lifting handle, hold back safety chains, spring operators for easy operation, and an automatic hold-open arm with vinyl grip release handle.
- D. Factory finish for exterior floor doors shall be mill finish with bituminous coating applied to all surfaces in contact with concrete.
- E. Where specified on the Drawings, floor doors shall be furnished with all stainless steel hardware.

- F. Exterior floor doors shall be single-leaf or double-leaf as shown on the Drawings and shall be Bilco Type J or JD, Babcock-Davis Type BD, or equal, unless noted otherwise on the Drawings.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Completely assemble all floor doors in the containing frames prior to their delivery to the job. Paint the exterior of the frames and anchors, or those portions coming in contact with the concrete, with a heavy coating of asphalt or other bituminous material prior to their installation.
- B. Install all sidewalk door frames so they will project slightly above the elevation of the surrounding concrete. No door shall be at an elevation lower than the adjacent concrete construction. They shall present a uniform, level surface with no indentations or projections. All hinged sidewalk doors shall operate freely and without binding.
- C. Connect gutters to plant drain piping as shown on the Drawings.

SECTION 08 33 23

OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Insulated service doors.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of overhead coiling door and accessory.

- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

- 1. Include points of attachment and their corresponding static and dynamic loads imposed on structure.

- 2. Include diagrams for power, signal, and control wiring.

- C. Samples: For each exposed product and for each color and texture specified.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.
 - 1. Design Wind Load: As indicated on Drawings.
 - 2. Testing: According to ASTM E 330.

2.2 DOOR ASSEMBLY

- A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Clopay Building Products.
 - b. Cornell Iron Works, Inc.
 - c. Overhead Door Corporation.
 - d. Raynor.
 - e. Wayne-Dalton Corp.
 - f. Or approved equal.
- B. Operation Cycles: Door components and operators capable of operating for not less than 100,000.
- C. Curtain R-Value: 4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W).
- D. Door Curtain Material: Aluminum.
- E. Door Curtain Slats: Curved profile slats of 2-5/8-inch (67-mm) center-to-center height.
 - 1. Insulated-Slat Interior Facing: Metal.
- F. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from aluminum extrusions and finished to match door.
- G. Curtain Jamb Guides: Aluminum with exposed finish matching curtain slats.
- H. Hood: Match curtain material and finish.
 - 1. Mounting: Face of wall.
- I. Locking Devices: Equip door with locking device assembly and chain lock keeper.

1. Locking Device Assembly: Cremone type, both jamb sides locking bars, operable from inside with thumb turn and outside with cylinder.

J. Electric Door Operator:

1. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day.
2. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use.
3. Motor Exposure: Exterior, wet, and humid.
4. Classified Listing: As indicated on electrical drawings for hazardous areas.
5. Emergency Manual Operation: Chain type.
6. Obstruction-Detection Device: Automatic photoelectric sensor.
7. Control Station(s): Interior mounted.

K. Curtain Accessories: Equip door with weatherseals.

L. Door Finish:

1. Aluminum Finish: Dark bronze anodized.
2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.3 MATERIALS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
1. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84 or UL 723. Enclose insulation completely within slat faces.
 2. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum aluminum thickness of 0.032 inch (0.80 mm).

- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.5 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
 - 1. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
 - 2. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

2.6 LOCKING DEVICES

- A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
 - 1. Lock Cylinders: Cylinders standard with manufacturer and keyed to building keying system.
 - 2. Keys: Three for each cylinder.
- B. Chain Lock Keeper: Suitable for padlock.
- C. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.7 CURTAIN ACCESSORIES

- A. Smoke Seals: Equip each fire-rated door with replaceable smoke-seal perimeter gaskets or brushes for smoke and draft control as required for door listing and labeling by a qualified testing agency.
- B. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

2.8 COUNTERBALANCING MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained

in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

- B. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.9 MANUAL DOOR OPERATORS

- A. General: Equip door with manual door operator by door manufacturer.
- B. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 30-lbf (133-N) force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

2.10 ELECTRIC DOOR OPERATORS

- A. Comply with NFPA 70.
 - 1. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated.
 - 1. Electrical Characteristics:
 - a. Phase: Single phase.
 - b. Volts: 115 V.
 - c. Hertz: 60.
 - 2. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
 - 3. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
- D. Obstruction Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.
 - 1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.

- E. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
 - 1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 - 2. Exterior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.
- F. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 30 lbf (133 N).
- G. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- H. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Power-Operated Doors: Install automatic garage doors openers according to UL 325.
- C. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion. Lubricate bearings and sliding parts as recommended by manufacturer. Adjust seals to provide tight fit around entire perimeter.

3.2 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

- 1. Mechanical [and electrified] door hardware for the following:
 - a. Swinging doors.
- 2. Field verification, preparation and modification of existing doors and frames to receive new door hardware.
- 3. Lead-lining door hardware items required for radiation protection at door openings.

B. Exclusions: Hardware for the following is not provided under the scope of this section, unless specifically listed in the hardware sets:

- 1. Windows
- 2. Cabinets (casework), including locks in cabinets
- 3. Signage
- 4. Toilet accessories
- 5. Overhead doors

C. Related Sections:

- 1. Division 01 Section "Alternates" for alternates affecting the work of this section.
- 2. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation under the work of this section.
- 3. Division 09 Sections for touchup finishing or refinishing of existing openings modified by the work of this section.

1.3 REFERENCES

- A. Applicable state and local building codes and standards.

B. Fire/Life Safety

1. NFPA - National Fire Protection Association
 - a. NFPA 70 – National Electric Code
 - b. NFPA 80 - Standard for Fire Doors and Fire Windows
 - c. NFPA 101 - Life Safety Code
 - d. NFPA 105 - Smoke and Draft Control Door Assemblies
2. State Fire Safety Code [and Amendments to CT Supplement].

C. UL - Underwriters Laboratories

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

D. Accessibility

1. ADA - Americans with Disabilities Act[Plus State Amendments].
2. ANSI A117.1 - Accessible and Usable Buildings and Facilities.

E. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware

F. ANSI - American National Standards Institute

1. ANSI/BHMA A156.1 - A156.29, and ANSI A156.31 - Standards for Hardware and Specialties

1.4 SUBMITTALS

A. General:

1. Submit the following in accordance with Conditions of Contract and Division 01 requirements.
2. Advise Engineer within the submittal package of incompatibility or issues which may detrimentally affect the work of this section.

3. Prior To Forwarding Submittal: Comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.

B. Action Submittals:

1. Product Data: Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of the hardware schedule, submit details of electrified door hardware, indicating the following:
 - a. Wiring Diagrams: For power, signal, and control wiring and including the following:
 - 1) Details of interface of electrified door hardware and building safety and security systems.
 - 2) Schematic diagram of systems that interface with electrified door hardware.
 - 3) Point-to-point wiring.
 - 4) Risers.
3. Samples for Verification: If requested by the Engineer, submit production sample or sample installations as requested of each type of exposed hardware unit in the finish indicated, and tagged with a full description for coordination with the schedule.
 - a. Samples will be returned to the supplier in like-new condition. Units that are acceptable to the Engineer may, after final check of operations, be incorporated into the Work, within limitations of key coordination requirements.
4. Door Hardware Schedule: Submit schedule with hardware sets in vertical format as illustrated by the Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Indicate complete designations of each item required for each door or opening. Include the following information:
 - a. Door Index; include door number, heading number, and Engineers hardware set number.
 - b. Opening Lock Function Spreadsheet; list locking device and function for each opening.
 - c. Type, style, function, size, and finish of each hardware item.

- d. Name and manufacturer of each item.
- e. Fastenings and other pertinent information.
- f. Location of each hardware set cross-referenced to indications on Drawings.
- g. Explanation of all abbreviations, symbols, and codes contained in schedule.
- h. Mounting locations for hardware.
- i. Door and frame sizes and materials.
- j. Name and phone number for the local manufacturer's representative for each product.
- k. Operational Description of openings with any electrified hardware (locks, exits, electromagnetic locks, electric strikes, automatic operators, door position switches, magnetic holders or closer/holder units, and/or access control components). Operational description should include how the door will operate on egress, ingress, and fire/smoke alarm connection.

- 1) Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.

5. Key Schedule:

- a. After a keying meeting between representatives of the Owner, Engineer, hardware supplier—provide a keying schedule listing the levels of keying as well as an explanation of the key system's function, the key symbols used and the door numbers controlled.
- b. Utilize ANSI A156.28 “Recommended Practices for Keying Systems” as a guideline for nomenclature, definitions, and approach for selecting the optimal keying system.
- c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
- d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.

- e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion.
 - 1) Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
 - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.
6. Templates: After final approval of the hardware schedule, provide templates for doors, frames and other work specified to be factory prepared for the installation of door hardware.

C. Informational Submittals:

- 1. Qualification Data: For Supplier, Installer and Engineerural Hardware Consultant.
- 2. Product Certificates for electrified door hardware, signed by the manufacturer:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
- 3. Certificates of Compliance:
 - a. Upon request of Engineer or Authority Having Jurisdiction certificates of compliance for fire-rated hardware and installation instructions shall be made available.
 - b. Installer Training Meeting Certification: Letter of compliance, signed by Contractor, attesting to completion of installer training meeting specified in "QUALITY ASSURANCE" article, herein.
 - c. Electrified Hardware Coordination Conference Certification: Letter of compliance, signed by Contractor, attesting to completion of electrified hardware coordination conference, specified in "QUALITY ASSURANCE" article, herein.
- 4. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
- 5. Warranty: Special warranty specified in this Section.

D. Closeout Submittals:

- 1. Operations and Maintenance Data : Provide in accordance with Division 01 and include the following:

- a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
- b. Catalog pages for each product.
- c. Name, address, and phone number of local representative for each manufacturer.
- d. Parts list for each product.
- e. Copy of final approved hardware schedule, edited to reflect conditions as-installed.
- f. Copy of final keying schedule.
- g. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
- h. Copy of warranties including appropriate reference numbers for manufacturers to identify the project.

1.5 QUALITY ASSURANCE

- A. Product Substitutions: For the purpose of performing the work of this section, comply with product requirements stated in Division 01 and as specified herein.
 1. Where a specific manufacturer's product is named and accompanied by the words "No Substitute," including make or model number or other designation, provide the product exactly as specified. (Note: Certain products have been selected for their unique characteristics and particular project suitability.)
 - a. Where no additional products or manufacturers are listed in a product category, requirements for "No Substitute" govern product selection.
 2. Where products indicate "acceptable substitute" or "acceptable manufacturer", provide product from specified manufacturers, subject to compliance with specified requirements and "Single Source Responsibility" requirements stated herein.
- B. Supplier Qualifications and Responsibilities: A recognized Engineerural hardware supplier that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides a certified Engineerural Hardware Consultant (AHC) available to the Owner, Engineer, and Contractor, at reasonable times during the course of the Work for consultation.
 1. Warehousing Facilities: In Project's vicinity.
 2. Scheduling Responsibility: Preparation of door hardware and keying schedules.

3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
4. Coordination Responsibility: Coordinate installation of the electronic security hardware with the Engineer and electrical engineers and provide installation and technical data to the Engineer and other related subcontractors.
 - a. Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.
- C. Installer Qualifications: Qualified tradesmen, skilled in the application of commercial grade hardware that has a record of successful in-service performance for installing door hardware similar in quantity, type, and quality to that indicated for this Project.
- D. Engineerural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who can meet the following qualification requirements:
 1. For door hardware, DHI-certified, Engineerural Hardware Consultant (AHC).
 2. Can provide installation and technical data to the Engineer and other related subcontractors.
 3. Can inspect and verify components are in working order upon completion of installation.
 4. Capable of producing wiring diagrams.
 5. Capable of coordinating installation of the electrified hardware with the Engineer and electrical engineers.
- E. Single Source Responsibility: Obtain each type of door hardware from a single manufacturer.
 1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated.
 2. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
- F. Fire-Rated Door Openings: Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations

acceptable to the authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

- G. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 - 1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at the tested pressure differential of 0.3-inch wg (75 Pa) of water.
- H. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- I. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- J. Accessibility Requirements: For door hardware on doors in an accessible route, comply with governing accessibility regulations cited in "REFERENCES" article, herein.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
 - 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
 - b. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
 - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high [and] 3/4 inch (19 mm) high for exterior sliding doors].
 - 4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
- K. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01.
 - 1. Attendees: Owner, Contractor, Engineer, Installer, Supplier's Engineerural Hardware Consultant [and Owner's security consultant].

2. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 - a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - b. Preliminary key system schematic diagram.
 - c. Requirements for key control system.
 - d. Requirements for access control.
 - e. Address for delivery of keys.
- L. Pre-installation Conference: Conduct conference at Project site <Insert alternate location>.
 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 2. Inspect and discuss preparatory work performed by other trades.
 3. EDIT - Retain first two subparagraphs below for electrified door hardware.
 4. Inspect and discuss electrical roughing-in for electrified door hardware.
 5. Review sequence of operation for each type of electrified door hardware.
 6. Review required testing, inspecting, and certifying procedures.
- M. Coordination Conferences:
 1. Installation Coordination Conference: Prior to hardware installation, schedule and hold a meeting for the purpose of reviewing any questions or concerns related to the proper installation and adjustment of door hardware.
 - a. Attendees: doors hardware supplier, door hardware installer, Contractor.
 - b. After the meeting, provide letter of compliance to the Engineer, indicating when the meeting was held and who was in attendance.
 2. Electrified Hardware Coordination Conference: Prior to ordering electrified hardware, schedule and hold a meeting for the purpose of coordinating door hardware with security, electrical, doors and frames, and other related suppliers.
 - a. Attendees: electrified door hardware supplier, doors and frames supplier, electrified door hardware installer, electrical subcontractor, Owner, [Owner's security consultant,] Engineer and Contractor.

- b. After meeting, provide letter of compliance to the Engineer, indicating when the coordination conference was held and who was in attendance.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
 1. Each article of hardware shall be individually packaged in manufacturer's original packaging.
- C. Project Conditions:
 1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
 2. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- D. Protection and Damage:
 1. Promptly replace products damaged during shipping with exactly the same products.
 2. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during the course of the Work.
 3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- E. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- F. Deliver keys [and permanent cores] to Owner by registered mail or overnight package service.

1.7 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate

provisions are made for locating and installing door hardware to comply with indicated requirements.

- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- E. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.
- F. Direct shipments not permitted, unless approved by the Contractor.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Years from date of Substantial Completion, for durations indicated.
 - a. Closers:
 - 1) Mechanical: 10 years.
 - 2) Electrified: 2 years.
 - b. Exit Devices:
 - 1) Mechanical: 3 years.
 - 2) Electrified: 1 year.
 - c. Locksets:
 - 1) Mechanical: 3 years.
 - 2) Electrified: 1 year.
 - d. Continuous Hinges: Lifetime warranty [10 years].
 - e. Key Blanks: Lifetime
 - 2. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

1.9 MAINTENANCE

A. Maintenance Tools:

1. Furnish One (1) complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The Awarding Authority has determined that certain products will be selected for their unique characteristics and particular project suitability to insure continuity of existing and future performance and maintenance standards. After investigating available product offerings the Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: "No Substitute."
1. Where "No Substitute" is noted, submittals and substitution requests for other products will not be considered.
- B. Approval of manufacturers other than those listed shall be in accordance with QUALITY ASSURANCE article, herein.
- C. Approval of products from manufacturers indicated as "Acceptable Manufacturer" in the following table is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.

Item	Scheduled Manufacturer	Acceptable Substitute
Hinges	Ives (IVE)	Hager, McKinney, Stanley
Continuous Hinges	Ives (IVE)	Hager, Stanley
Flush Bolts & Coordinators	Ives (IVE)	Burns, Rockwood
Locksets & Deadlocks	Falcon (FAL)	Best, Sargent
Exit Devices & Mullions	Falcon (FAL)	Precision, Sargent
Cylinders & Keying	Falcon (FAL)	Best, Corbin-Russwin, Sargent, Schlage
Door Closers	Falcon (FAL)	Norton, Sargent
Door Trim	Ives (IVE)	Hager, Rockwood
Protection Plates	Ives (IVE)	Hager, Rockwood
Overhead Stops	Glynn-Johnson (GLY)	ABH, Rixson
Stops & Holders	Ives (IVE)	Hager, Rockwood
Thresholds & Weatherstrip	Reese (REE)	Pemko, Zero
Silencers	Ives (IVE)	Hager, Rockwood
Key Cabinets	Lund (LUN)	Telkee

- D. Hand of Door: Drawings show direction of slide, swing, or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.
- E. Where the hardware specified is not adaptable to the finished shape or size of the members requiring hardware, furnish suitable types having the same operation and quality as the type specified, subject to the Engineer's approval.

2.2 EXISTING MATERIALS

- A. Where existing door hardware is indicated to be removed and reinstalled:
 - 1. Carefully remove door hardware and components.
 - 2. Clean, protect and store existing door hardware in accordance with storage and handling requirements specified herein.
 - 3. Reinstall in accordance with installation requirements for new door hardware.

2.3 MATERIALS

- A. Fasteners
 - 1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
 - 2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
 - 3. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent that no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Review door specification and advise Engineer if thru-bolts are required.
 - 4. Hardware shall be installed with the fasteners provided by the hardware manufacturer.
- B. Modification and Preparation of Existing Doors: Provide necessary fillers, Dutchmen, reinforcements, and fasteners, compatible with existing materials, as required for mounting new opening hardware and to cover existing door and frame preparations.
 - 1. When possible, use materials which match materials of adjacent modified areas.
 - 2. When modifying existing fire-rated openings, provide materials permitted by NFPA 80 as required to maintain fire-rating.

- C. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
 - 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.4 HINGES

A. Manufacturers:

- 1. Scheduled Manufacturer: Ives 5BB series.
- 2. Acceptable Substitute: Hager, Stanley

B. Requirements:

- 1. 1-3/4 inch thick doors, up to and including 36 inches wide:
 - a. Exterior: standard weight, bronze/stainless steel, 4-1/2 inches high
 - b. Interior: standard weight, steel, 4-1/2 inches high
- 2. 1-3/4 inch thick doors over 36 inches wide:
 - a. Exterior: heavy weight, bronze/stainless steel, 5 inches high
 - b. Interior: heavy weight, steel, 5 inches high
- 3. 2 inches or thicker doors:
 - a. Exterior: heavy weight, bronze/stainless steel, 5 inches high
 - b. Interior: heavy weight, steel, 5 inches high
- 4. Provide three hinges per door leaf for doors 90 inches or less in height, and one additional hinge for each 30 inches of additional door height.
- 5. Where new hinges are specified for existing doors and/or existing frames, the new hinge size must be identical to hinge preparation present in the existing door and/or existing frame.
- 6. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins

e. Interior Non-lockable Doors: Non-rising pins

7. The width of hinges shall be 4-1/2 inches at 1-3/4 inch thick doors, and 5 inches at 2 inches or thicker doors. Adjust hinge width as required for door, frame, and/or wall conditions to allow proper degree of opening.
8. Provide hinges with electrified option where specified. Provide with sufficient number and gage of concealed wires to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to the electrified locking component.
9. Provide mortar guard for each electrified hinge specified, unless specified in hollow metal frame specification.
10. Provide spring hinges where specified. Provide two spring hinges and one bearing hinge per door leaf for doors 90 inches or less in height. Provide one additional bearing hinge for each 30 inches of additional door height.

C. Aluminum Geared

1. Manufacturers:

- a. Scheduled Manufacturer: Ives.
- b. Acceptable Substitute: Hager, Stanley.

2. Requirements:

- a. Provide aluminum geared continuous hinges conforming to ANSI A156.25, Grade 2.
- b. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum, with .25 inch diameter Teflon coated stainless steel hinge pin.
- c. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
- d. Hinges shall be capable of supporting door weights up to 450 pounds, and shall be successfully tested for 1,500,000 cycles.
- e. On fire-rated doors, provide aluminum geared continuous hinges that are classified for use on rated doors by a testing agency acceptable to the authority having jurisdiction.
- f. Provide aluminum geared continuous hinges with electrified option where specified. Provide with sufficient number and gage of concealed wires to accommodate electric function of specified hardware.

- g. Install hinges with fasteners supplied by manufacturer. Hole pattern shall be symmetrically patterned.

2.5 FLUSH BOLTS

A. Manufacturers:

- 1. Scheduled Manufacturer: Ives
- 2. Acceptable Substitute: Hager, Rockwood

B. Requirements:

- 1. Provide automatic and manual flush bolts with forged bronze face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch steel or brass rods at doors up to 90 inches in height. Top rods at manual flush bolts for doors over 90 inches in height shall be increased by 6 inches for each additional 6 inches of door height. Provide dust-proof strikes at each bottom flush bolt.

2.6 COORDINATORS

A. Manufacturers:

- 1. Scheduled Manufacturer: Ives
- 2. Acceptable Substitute: Hager, Rockwood

B. Requirements:

- 1. Provide a bar-type coordinating device, surface applied to the underside of the stop at the frame head where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors.
- 2. Provide a filler bar of the correct length for the unit to span the entire width of the opening, and appropriate brackets for parallel arm door closers and surface vertical rod exit device strikes. Factory-prep coordinators for vertical rod devices if required.

2.7 MORTISE LOCKS

A. Manufacturer:

- 1. Scheduled Manufacturer: Falcon M series
- 2. Acceptable Substitute: Best 45H series, Sargent 8200 series,

B. Requirements:

1. Provide mortise locks certified as ANSI A156.13, Grade 1 Operational, and manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance. Lock case shall be multi-function and field reversible for handing without opening the case. Cylinders: Refer to "KEYING" article, herein.
2. Provide locks with a standard 2-3/4 inches backset with a full 3/4 inch throw stainless steel mechanical anti-friction latchbolt. Deadbolt shall be a full 1 inch throw, constructed of stainless steel.
3. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
4. Provide electrical options as scheduled. Provide electrified locksets with micro switch (RX) option that monitors the retractor crank, and is actuated when rotation of the inside or outside lever rotates the retractor hub. Provide normally closed contacts or normally open contacts as required by security system.
5. Lever trim shall be solid brass, bronze, or stainless steel, cast or forged in the design specified, with wrought roses and external lever spring cages. Levers shall be thru-bolted to assure proper alignment, and shall have a 2-piece spindle.
 - a. Lever design shall be Falcon DG-Dane Gala.
 - b. Lever trim on the secure side of doors serving rooms considered by the authority having jurisdiction to be hazardous shall have a tactile warning.

2.8 CYLINDRICAL LOCKS – GRADE 1

A. Manufacturer:

1. Scheduled Manufacturer: Falcon T Series
2. Acceptable Substitute: Best 9K series, Sargent 10-Line

B. Requirements:

1. Provide cylindrical locks conforming to ANSI A156.2 Series 4000, Grade 1. Cylinders: Refer to "KEYING" article, herein.
2. Provide locks with a standard 2-3/4 inches backset, unless noted otherwise, with a 1/2 inch latch throw. Provide proper latch throw for UL listing at pairs.
3. Provide locksets with a separate anti-rotation throughbolts, and shall have no exposed screws. Levers shall operate independently, and shall have two external return spring cassettes mounted under roses to prevent lever sag.

4. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
5. Provide electrical options as scheduled.
6. Lever trim shall be solid cast levers without plastic inserts, and wrought roses on both sides. Locksets shall be thru-bolted to assure proper alignment.
 - a. Lever design shall be Falcon D-Dane.
 - b. Lever trim on the secure side of doors serving rooms considered by the authority having jurisdiction to be hazardous shall have a tactile warning.

2.9 EXIT DEVICES

A. Manufacturers:

1. Scheduled Manufacturer: Falcon 24/25 series with deadlatching
2. Acceptable Substitute: Sargent 80 series with deadlatching, Precision Apex series

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1, and UL listed for Panic Exit and/or Fire Exit Hardware. Cylinders: Refer to "KEYING" article, herein.
2. Exit devices shall be touchpad type, fabricated of brass, bronze, stainless steel, or aluminum, plated to the standard Engineerural finishes to match the balance of the door hardware.
3. Touchpad shall extend a minimum of one half of the door width. Touch-pad finish shall be compatible to exit device finish. Compression springs will be used in devices, latches, and outside trims or controls, tension springs also acceptable.
4. Devices to incorporate a deadlatching feature for security and/or for future addition of alarm kits and/or other electrical requirements.
5. Provide manufacturer's standard strikes.
6. Provide exit devices cut to door width and height. Locate exit devices at a height recommended by the exit device manufacturer, allowable by governing building codes, and approved by the Engineer.
7. Mechanism case shall sit flush on the face of all flush doors, or spacers shall be furnished to fill gaps behind devices. Where glass trim or molding projects off the face of the door, provide glass bead kits.
8. Non-fire-rated exit devices shall have cylinder [hex key] dogging.

9. Removable mullions shall be a 2 inches x 3 inches steel tube. Where scheduled, mullion shall be of a type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
10. Where lever handles are specified as outside trim for exit devices, provide heavy-duty lever trims with forged or cast escutcheon plates. Provide vandal-resistant levers that will travel to a 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.
 - a. Lever style will match the lever style of the locksets.
 - b. Lever trim on doors serving rooms considered by the authority having jurisdiction to be hazardous shall have a tactile warning.
11. Exit devices for fire rated openings shall be UL labeled fire exit hardware.
12. Field drill weep holes per manufacturer's recommendation for exit devices used in full exterior application, highly corrosive areas, and where noted in the hardware sets.
13. Provide electrical options as scheduled.
 - 1) Modulation: 900 MHz spread spectrum, direct sequence, 10 channels.
 - 2) Encryption: AES-128 bit Key minimum.

2.10 CYLINDERS

A. Manufacturer:

1. Scheduled Manufacturer: Falcon
2. Acceptable Substitute: Best, Sargent

B. Requirements: Provide cylinders/cores complying with the following requirements.

1. Furnished by same manufacturer as locks.
2. Cylinders/cores compliant with ANSI/BHMA A156.5; latest revision, Section 12, Grade 1; permanent cylinders; cylinder face finished to match lockset, manufacturer's series as indicated.
 - a. Full-sized cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.
 - 1) Conventional cylinder with interchangeable core (SFIC)] core.
3. Keying: Manufacturer-keyed permanent cylinders/cores, configured into keying system per "KEYING" article herein.

4. Features: Cylinders/cores shall incorporate the following features.
 - a. Nickel silver bottom pins.
 5. Identification:
 - a. Mark permanent cylinders/cores and keys with applicable blind code per DHI publication "Keying Systems and Nomenclature" for identification. Blind code marks shall not include actual key cuts.
 - b. Identification stamping provisions must be approved by the Engineer and Owner.
 - c. Failure to comply with stamping requirements shall be cause for replacement of cylinders/cores involved at no additional cost to Owner.
 6. Forward cylinders/cores to Owner, separately from keys, by means as directed by Owner.
- C. Project Cylinder/Core Distribution: Provide cylinders/cores complying with the following requirements in Project locations as indicated.
1. Interior and Exterior Doors: Conventional cylinders with interchangeable cores.
 2. Owner or Owner's Representative will void operation of temporary construction keys.
- D. Replaceable Construction Cores.
1. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
 - a. 12 construction change (day) keys.
 2. Owner or Owner's Representative will replace temporary construction cores with permanent cores.

2.11 KEYING

- A. Keying System: Factory registered, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- B. Keying Requirements – General
1. Permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - a. Keying system tied into existing system as directed by the Owner.

2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements shall be cause for replacement of cylinders/cores involved at no additional cost to Owner.

C. Keys

1. Material: Nickel silver; minimum thickness of .092-inch (2.3mm)
2. Identification:
 - a. Coordinate with cylinder/core and key identification requirements above.
 - b. Stamp keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
 - c. Failure to comply with stamping requirements shall be cause for replacement of keys involved at no additional cost to Owner.
3. Quantity: Furnish in the following quantities.
 - a. Change (Day) Keys: 3 per cylinder/core.
 - b. Permanent Control Keys: 3.
 - c. Master Keys: 6.
 - d. Unused balance of key blanks shall be furnished to Owner with the cut keys.

2.12 KEY CONTROL SYSTEM

A. Key Control System Manufacturers:

1. Scheduled Manufacturer: Lund
2. Acceptable Substitution: Telkee

B. Requirements:

1. Provide a key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of the number of locks required for the Project.
 - a. Provide complete cross index system set up by the hardware supplier, and place keys on markers and hooks in the cabinet as determined by the final key schedule.

- b. Provide hinged-panel type cabinet for wall mounting.

2.13 DOOR CLOSERS

A. Manufacturers:

1. Scheduled Manufacturer: Falcon SC70 series
2. Acceptable Manufacturers: Norton 7500 series, Sargent 351

B. Requirements:

1. Provide door closers certified to ANSI/BHMA A156.4 Grade 1 requirements by a BHMA certified independent testing laboratory. Closers shall be ISO 9000 certified. Units shall be stamped with date of manufacture code.
2. Door closers shall have fully hydraulic, full rack and pinion action with an aluminum cylinder. Closer body shall be 1-1/2 inch diameter, and heat-treated pinion journal shall be 11/16 inch diameter.
3. Provide hydraulic fluid requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to 10 degrees F. Fluid shall be fireproof and shall pass the requirements of the UL10C "positive pressure" fire test.
4. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force as required by accessibility codes and standards. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed, and backcheck.
5. Closers shall not incorporate Pressure Relief Valve (PRV) technology.
6. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting..

2.14 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer: Ives.
2. Acceptable Substitution: Hager, Rockwood.

B. Requirements:

1. Provide push plates 4 inches wide x 16 inches high x 0.050 inch thick and beveled 4 edges. Where width of door stile prevents use of 4 inches wide plate, adjust width to fit.

2. Provide push bars of solid bar stock, diameter and length as scheduled. Push bars shall be of sufficient length to span from center to center of each stile. Where required, mount back to back with pull.
3. Provide offset pulls of solid bar stock, diameter and length as scheduled. Where required, mount back to back with push bar.
4. Provide flush pulls as specified. Where required, provide back-to-back mounted model.
5. Provide pulls of solid bar stock, diameter and length as scheduled. Where required, mount back to back with push bar.
6. Provide pull plates 4 inches wide x 16 inches high x 0.050 inch thick, beveled 4 edges, and prepped for pull. Where width of door stile prevents use of 4 inches wide plate, adjust width to fit.
7. Provide wire pulls of solid bar stock, diameter and length as scheduled.

2.15 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer: Ives.
2. Acceptable Substitute: Hager, Rockwood.

B. Requirements:

1. Provide kick plates, mop plates, and armor plates minimum of 0.050 inch thick as scheduled. Furnish with machine or wood screws, finished to match plates. Sizes of plates shall be as follows:
 - a. Kick Plates – 10 inches high x 2 inches less width of door on single doors, 1 inch less width of door on pairs
 - b. Mop Plates – 4 inches high x 2 inches less width of door on single doors, 1 inch less width of door on pairs
 - c. Armor Plates – 36 inches high x 2 inches less width of door on single doors, 1 inch less width of door on pairs

2.16 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers: Glynn-Johnson
2. Acceptable Substitutes: ABH, Rixson

B. Requirements:

1. Provide heavy duty concealed mounted overhead stop or overhead stop/holder as specified for exterior and interior vestibule single acting doors.
2. Provide heavy duty concealed mounted overhead stop or overhead stop/holder as specified for double acting doors.
3. Provide heavy or medium duty and concealed or surface mounted overhead stop or overhead stop/holder for interior doors as specified. Provide medium duty surface mounted overhead stop for interior doors and at any door that swings more than 140 degrees before striking a wall, open against equipment, casework, sidelights, and/or where conditions do not allow a wall stop or a floor stop presents a tripping hazard.
4. Where overhead holders are specified provide friction type at doors without a closer and positive type at doors with a closer.

2.17 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer: Ives.
2. Acceptable Substitution: HagerBurns, Rockwood.

B. Provide door stops for all doors in accordance with the following requirements:

1. Provide wall stops wherever possible. Provide convex type where mortise type locks are used and concave type where cylindrical type locks are used.
2. Where wall stops cannot be used, provide a medium duty surface mounted overhead stop.

2.18 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer: National Guard Products
2. Acceptable Substitutions: Pemko, Zero.

B. Requirements:

1. Provide thresholds, weatherstripping (including door sweeps, seals, astragals) and gasketing systems (including smoke, sound, and light) as specified and per Engineerural details. Match finish of other items as closely as possible. Size of thresholds shall be as follows:

- a. Saddle Thresholds – 1/2 inch high x jamb width x door width
 - b. Bumper Seal Thresholds – 1/2 inch high x 5 inches wide x door width
2. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.

2.19 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer: Ives.
2. Acceptable Substitutions: Hager, Rockwood.

B. Requirements:

1. Provide "Push-in" type silencers for each hollow metal or wood frame. Provide three for each single frame and two for each pair frame. Omit where gasketing is specified or required by code.

2.20 FINISHES

A. Finish of all hardware shall be US26D (BHMA 626/652) with the exceptions as follows:

1. Hinges at Exterior Doors: US32D (BHMA 630).
2. Continuous Hinges: Clear Anodized Aluminum).
3. Push Plates, Pulls, and Push Bars: US32D (BHMA 630).
4. Protection Plates: US32D (BHMA 630).
5. Overhead Stops and Holders: US32D (BHMA 630).
6. Door Closers: Powder Coat to Match.
7. Wall Stops: US32D (BHMA 630).
8. Latch Protectors: US32D (BHMA 630).
9. Weatherstripping: Clear Anodized Aluminum.
10. Thresholds: Mill Finish Aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Existing Door and Frame Compatibility: Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with the existing door and frame preparation and existing conditions.
- C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Where on-site modification of doors and frames is required, prepare hardware locations in accordance with the following:
 - 1. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
 - 2. Wood Doors: Comply with DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
 - 3. Where doors are in rated assemblies, comply with NFPA 80 for restrictions on on-site door hardware preparation.
 - 4. Where on-site modification of existing doors and frames is required:
 - a. Remove existing hardware being replaced, tag, and store according to contract documents.
 - b. Field modify and prepare existing door and/or frame for new hardware being installed.
 - c. When modifications are exposed to view, use concealed fasteners, when possible.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Custom Steel Doors and Frames: HMMA 831.

3. Wood Doors: DHI WDHS.3, "Recommended Locations for Engineerural Hardware for Wood Flush Doors."
- B. Install each hardware item in compliance with the manufacturer's instructions and recommendations, using only the fasteners provided by the manufacturer.
- C. Do not install surface mounted items until finishes have been completed on the substrate. Protect all installed hardware during painting.
- D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- F. Operating parts shall move freely and smoothly without binding, sticking, or excessive clearance.
- G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- H. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches (750 mm) of door height greater than 90 inches (2286 mm).
- I. Lock Cylinders: Install construction cores to secure building and areas during construction period.
1. Replace construction cores with permanent cores as indicated in keying section.
- J. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- K. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Closers shall not be visible in corridors, lobbies and other public spaces unless approved by Engineer.
- L. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- M. Thresholds: Set thresholds scheduled herein, in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- N. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present a tripping hazard.

- O. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- P. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- Q. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

- A. Engineerural Hardware Consultant: Engage a qualified independent Engineerural Hardware Consultant to perform inspections and to prepare inspection reports.
 - 1. Engineerural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
 - 2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 - 3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three [six] <Insert number> months after date of Substantial Completion, Installer's Engineerural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

- A. Provide training for the Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

3.8 DOOR HARDWARE SCHEDULE

- A. Provide hardware for each door to comply with requirements of this section and the below-listed scheduled sets.
- B. It is intended that the following schedule includes complete items of door hardware necessary to complete the work. If a discrepancy is found in the scheduled hardware sets, such as a missing item, improper hardware for a frame, door or fire codes, provisions of the above-specifications shall govern.
- C. Locksets, exit devices, and other hardware items are referenced in the following hardware sets for series, type and function. Refer to the above-specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets:

Hardware Set	Finish Hardware
1	3-Hinges 1-Classroom style lockset and strike 1-Set panic hardware 1-Door closer 3-Silencers (installed on frame) 1-Kickplate 1-Aluminum threshold
2	6-Hinges 1- Classroom style lockset and strike 1-Set panic hardware (active leaf) 2-Extention bolts (inactive leaf) 4-Silencers 2-Kickplate 2-Door closer 1-Aluminum threshold
3	6-Hinges 2-Dummy Handles 2-Push Plates 4-Silencers 2-Kickplate 2-Door closer 1-Aluminum threshold

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
 - 2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For dimpled steel studs and runners AND firestop tracks, from ICC-ES.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.

2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- B. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.
1. Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
 - b. Depth: As indicated on Drawings.
 2. Dimpled Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.025 inch (0.64 mm).
 - b. Depth: As indicated on Drawings.
- C. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fire Trak Corp.; Fire Trak System (BlazeFrame where indicated).
 - b. Grace Construction Products; FlameSafe FlowTrak System.
 - c. Metal-Lite, Inc.; The System.
 - d. Or approved equal.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
- E. Cold-Rolled Channel Bridging: Steel, 0.053-inch (1.34-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
1. Depth: 1-1/2 inches (38 mm).
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).

2. Depth: As indicated on Drawings.
- G. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
 1. Configuration: Asymmetrical or hat shaped.
- H. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 1. Depth: As indicated on Drawings.
 2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch (0.8 mm).
 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.018 inch (0.45 mm), and depth required to fit insulation thickness indicated.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
 - 3. Tile Backing Panels: 16 inches (406 mm) o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
 - 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches (150 mm) o.c.
- E. Direct Furring:
 - 1. Screw to wood framing where applicable.

2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

F. Z-Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches (1219 mm) o.c.
2. Carrying Channels (Main Runners): 48 inches (1219 mm) o.c.
3. Furring Channels (Furring Members): 16 inches (406 mm) o.c.

- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

- C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

- a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

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SECTION 09 91 00

PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes painting of all work indicated on the Contract Documents and as specified herein on the following substrates:

- 1. Exterior Substrates:

- a. Concrete, vertical and horizontal surfaces.
- b. Clay masonry.
- c. Concrete masonry units (CMU).
- d. Steel.
- e. Galvanized metal.
- f. Aluminum (not anodized or otherwise coated).
- g. Wood.
- h. Plastic trim fabrications.
- i. Exterior Portland cement (stucco).
- j. Exterior gypsum board.

- 2. Interior Substrates:

- a. Concrete, vertical and horizontal surfaces.
- b. Clay masonry.
- c. Concrete masonry units (CMU).
- d. Steel.
- e. Galvanized metal.
- f. Aluminum (not anodized or otherwise coated).

- g. Wood.
- h. Gypsum board.
- i. Plaster.
- j. Spray-textured ceilings.
- k. Cotton or canvas insulation covering.

3. Chemical Resistant Linings

- B. This Section does not include the painting of any bolts, nuts, or other fasteners included within the Work. Unless otherwise indicated within the Contract Documents, all fasteners are not to be painted.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

- 1. ASTM International (ASTM)
 - a. D2246 - Freeze-Thaw Test
 - b. D4585 - Humidity Test
 - c. B117 - Salt Spray Test
 - d. E84 - Surface Burning Characteristics Test
 - e. D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products
 - f. D2805 - Contrast Ratio
 - g. D1308 - Stain Resistance
 - h. D4060 – Abrasion
 - i. D4541 – Adhesion
 - j. D522 - Conical Mandrel Elongation
- 2. SSPC: The Society for Protective Coatings (SSPC)
 - a. SSPC Painting Manual, Volume 2, Systems and Specifications

1.4 QUALITY ASSURANCE

- A. All materials shall remain in their original containers with manufacturer's label intact. Manufacturer's name, product name and number, and color and batch number, shall appear on the label.
- B. Manufacturer's representative shall be available to advise applicator on proper application techniques and procedures.

1.5 SUBMITTALS

- A. In addition to those submittals identified in the General Provisions, the following items shall be submitted:
 - 1. Manufacturer's descriptive data fully describing each product to include solids by volume and volatile organic chemicals (VOC) ratings.
 - 2. Manufacturer's application instructions.
 - 3. Color charts illustrating range of colors available for selection.
 - 4. A three-ring binder of Material Safety Data Sheets of all chemicals used on-site during the Work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.
 - 3. Provide proper storage of all paint products per Manufacturer's instructions and any other current regulations or requirements that may be applicable..

1.7 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F, unless otherwise restricted or allowed by the Manufacturer.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. And per Manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Sherwin-Williams products are named to establish a standard of quality necessary for the Project. The following manufacturers are acceptable alternatives:
 - 1. Tnemec Company.
 - 2. DuPont.
 - 3. International Protective Coatings.
 - 4. Or approved equal.

2.2 GENERAL

- A. Coatings shall be applied per manufacturer's recommendations.
- B. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another, manufacturer's primers used before leaving the shop specified elsewhere and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
 - 3. All coordination for compatibility between shop primers, shop finish coats, field coats, and possible tie coats, shall be the responsibility of the Contractor.
- C. Clean damaged shop coatings and retouch before any successive field painting is performed.
- D. Field surfaces prepared for field painting will be reviewed by the Engineer and/or Paint Manufacturer's representative before coating application begins.
- E. Apply coatings with a brush or a roller. Spray paint only where scheduled or with Engineer's review and City's approval.
- F. Colors: As indicated in a color schedule.

PART 3 - EXECUTION

3.1 PRE-APPLICATION

- A. Examine surfaces to be coated and report any conditions that would adversely affect the appearance or performance of the coating systems, and which cannot be put into an acceptable condition by the preparatory work specified.
- B. The Contractor shall verify that moisture content of surfaces is within manufacturer's recommendations.
- C. Beginning of installation means acceptance of substrate by the Contractor.
- D. Provide required drop cloths and protection covers to protect surfaces during surface preparation and painting processes. Protect working parts of mechanical and electrical equipment. Protect newly painted surfaces from contamination and overspray.

3.2 SURFACE PREPARATION

- A. General
 - 1. Remove dust and loose material by dusting, sweeping, vacuuming, or blowing with high-pressure air.
 - 2. Remove oil, wax, and grease in accordance with the manufacturer's recommendations.
 - 3. Verify with Engineer that all surfaces to be coated are dry, clean, and free from dirt, dust, wax, grease, or other contaminants.
 - 4. Remove electrical plates, hardware, light fixtures, trim, and fittings prior to preparing surfaces.
 - 5. Shellac and/or seal marks which may bleed through protective coatings that could not be removed.
- B. Metals
 - 1. Previously painted atmospherically exposed metals NOT scheduled for abrasive blast cleaning shall be cleaned in accordance with SSPC-SP 3.
 - 2. Prepare all non-primed metal surfaces in accordance with the SSPC Painting Manual.
 - a. Abrasive blast cleaning shall conform to the SSPC Surface Preparations Specifications for near-white blast cleaning (SSPC-SP 10) or commercial blast cleaning (SSPC-SP 6).

- b. Before abrasive blast cleaning begins, the Contractor shall prepare a sample which shall correspond to the photographic standards of SSPC.
 - c. Proportions of abrasive shall be adjusted as necessary to produce a prepared surface equivalent to the reviewed sample.
 - d. Applications of protective coatings shall be within 8 hours after blast cleaning or before any rusting has occurred.
 - e. Surfaces showing any traces of rust shall be abrasive blast cleaned again before application of protective coatings.
 - f. In areas where assemblies are to receive an abrasive blast cleaned surface preparation, and portions of the assembly have been previously coated, all prior coatings shall be removed by blast cleaning to the extent necessary for proper adhesion of the specified coating.
3. Shop Primed Metals or Ferrous Metals
- a. Abrasive blast clean or SSPC-SP11-Power Tool Clean To Bare Metal (SSPC-SP 15 Commercial Grade Power Tool Cleaning is acceptable for non-immersion service) all field connections, welds, burned, and abraded areas to remove rust and contaminants; touch up with specified primer. Feather edges to make patches inconspicuous where exposed to view.
4. Ferrous Metal - Submerged Service
- a. SSPC-SP10 - Near White Blast Clean
5. Ferrous Metal - Non-Submerged Service
- a. Previously painted atmospherically exposed metals NOT scheduled for abrasive blast cleaning shall be cleaned in accordance with SSPC-SP 3.
 - b. SSPC-SP6 - Commercial Blast Clean
6. Non-Ferrous Metal
- a. SSPC-SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
7. Galvanized Metal
- a. SSPC-SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals

8. Ductile Or Cast Iron

- a. Prepare ductile or cast iron surfaces in accordance with NAPF 500-03-04 Abrasive Blast Cleaning with the exception that ALL rust and mold coating be removed. Only tightly adherent annealing oxide may remain.
- b. Bituminous coated pipe shall NOT be allowed if field painting is required.
- c. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Concrete and Masonry

1. Allow new concrete and masonry to cure 28 days.
2. Patch holes and cracks in the concrete flush with the surface using a Portland cement grout patching material or equivalent.
3. Clean mortar joints
4. Remove stains caused by weathering or corroding metals by cleaning with manufacturer's approved methods.
5. Verify required acid/alkali balance and allowable moisture content of material.
6. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.

D. Wood

1. Wipe off dust and grit just prior to painting.
2. Remove or seal all pitch or deposits with a sealer compatible with the finish coating system.
3. Seal knots and sappy sections with a sealer compatible with the finish coating system.
4. Exterior Wood
 - a. After prime coat has been applied, fill nail holes with [tinted] caulking compound suitable for an exterior application, and compatible with the coating system.
5. Glue-Laminated Beams
 - a. Prior to finishing, wash surfaces with solvent.

- 6. Interior Wood
 - a. After primer has dried, fill nail holes and cracks with wood filler; sand between coats.
- 7. Smooth Siding and Finish Woodwork
 - a. Sand rough, irregular spots.
- E. Plaster
 - 1. Wash and neutralize high alkali surfaces.
- F. Gypsum Wall Board
 - 1. Verify surface is free of dust, and ready to receive primer.
- G. Impervious Surfaces
 - 1. Remove mildew and mold in accordance with the manufacturer's recommendation.

3.3 APPLICATION

- A. Mix and thin material in accordance with the manufacturer's printed instructions.
- B. In general, spread material evenly and smoothly without runs, sags, or other defects. Primary movement of the brush shall describe a series of small circles to fill irregularities in the surface, after which apply parallel strokes. Apply finish coats vertically on all vertical surfaces. Apply paint in all corners and crevices. Make edges of paint adjoining other color or material sharp and neat without overlapping.
- C. Apply paint by brush, rollers, or spray gun as recommended by paint manufacturer.
 - 1. Use only good quality brushes and accessories appropriate for the system applied.
 - 2. Use only flat brushes that have a width of four and one-half inches or less.
 - 3. Use oval or round brushes with a width of two and one-half inches or less for painting railings and open grid steel decking.
- D. Allow sufficient time between each coat as recommended by paint manufacturer. Allow each coat to dry thoroughly before recoating. Sand surfaces as necessary between coats to produce a smooth finish.
- E. Paint all exposed surfaces. Prime all sides, cut ends, and edges. Parts of any member inaccessible after installation shall be painted before installation.

- F. Take necessary action to prevent dust and dirt from coming in direct contact with freshly painted surfaces.
- G. Vary color slightly to indicate each successive coating.
- H. Cut in edges clean and sharp where work joins other materials or colors.
- I. Make finish coats smooth, uniform in color and free of brush marks, laps, runs, dry spray, overspray, and missed areas.
- J. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- K. Prime back surfaces of interior and exterior woodwork with primer paint.
- L. Back-paint aluminum coming in contact with concrete.

3.4 UNCOATED MATERIALS AND ITEMS

- A. Nuts, bolts, or other fasteners included within the Work.
- B. Glazed wall finishes, special coatings, and floor finishes are specified elsewhere.
- C. Surfaces not requiring protective coatings:
 - 1. Brass, Aluminum, Bronze, Copper, Stainless Steel.
 - 2. Galvanized steel pipe supports..

3.5 PAINTING SCHEDULE

Notes and Legend

- (1) Brush, roller or spray application on metal surfaces such as, but not limited to ceiling decks and bar joists may require two coats to achieve full coverage of the required coat mil thickness.
- (2) Actual film thickness will depend on porosity of surface, such as but not limited to concrete, masonry, gypsum, plaster and wood.

(DFT) = Dry Film Thickness

- A. STEEL-STRUCTURAL, TANKS, PIPES, EQUIPMENT, FERROUS PIPING, VALVES, OPERATORS, MISC. APPURTENANCES INSTALLED WITHIN THE PIPELINE.
 - 1. Exterior, Non-Immersion
 - a. System Type: Epoxy*/epoxy/urethane.

- b. Surface Preparation: SSPC-SP 6 with a surface profile of 2.0 to 3.0 mils.
 - c. Primer*: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - d. Intermediate Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - e. Finish Coat: Acrolon Ultra or Hi-Solids Polyurethane. DFT 2.0 to 4.0 mils.
 - f. Total DFT: 8.0 to 14.0 mils.
 - g. Finish Color: As indicated on the drawings or color schedule.
- *Copoxy Shop Primer and Corothane I Galvapak Zinc Primer are also acceptable

2. Interior, Non-Immersion

- a. System Type: Epoxy*/epoxy/epoxy.
 - b. Surface Preparation: SSPC-SP 6 with a surface profile of 2.0 to 3.0 mils.
 - c. Primer*: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - d. Intermediate Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - e. Finish Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - f. Total DFT: 9.0 to 15.0 mils.
 - g. Finish Color: As indicated on the drawings or color schedule.
- *Copoxy Shop Primer and Corothane I Galvapak Zinc Primer are also acceptable.

3. Interior, Non-Immersion (Previously Painted Piping)

- a. System Type: Epoxy/epoxy/epoxy.
- b. Surface Preparation: SSPC-SP 3
- c. Primer*: Macropoxy 646. DFT 3.0 to 5.0 mils.
- d. Finish Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
- e. Total DFT: 6.0 to 10.0 mils.
- f. Finish Color: As indicated on the drawings or color schedule.

* Verify compatibility of primer with existing coating before applying Finish Coat.

4. Immersion, Potable Water – NOT USED
5. Immersion, Wastewater
 - a. System Type: Epoxy Flake Filled/epoxy Flake Filled
 - b. Surface Preparation: SSPC-SP 10
 - c. OPTIONAL Shop Primer: Copoxy. DFT 3.0 to 5.0 mils.
 - d. Primer: Sher-Glass FF: DFT 8.0 to 12.0 mils.
 - e. Finish Coat: Sher-Glass FF: DFT 8.0 to 12.0 mils.
 - f. Total DFT: 16.0 to 24.0 mils excluding optional shop primer.*
 - g. Finish Color: As indicated on the drawings or color schedule.

*Spray apply Dura-Plate UHS for one or two coat application. OAP technology strongly recommended. COAL TAR EPOXY SHALL NOT BE USED.

6. High Temperature Surfaces Up To 800°F – NOT USED

B. GALVANIZED STEEL, NON-FERROUS METAL, PIPE, ROOF DECK AND MISCELLANEOUS FABRICATIONS (INCLUDING INTERIOR PIPE SUPPORTS, CONDUIT SUPPORTS, AND DUCT SUPPORTS)

1. Exterior, Non-Immersion
 - a. System Type: Epoxy/urethane.
 - b. Surface Preparation: SSPC SP 16.
 - c. Primer: Macropoxy 646. DFT 3.0 to 5.0 mils.
 - d. Finish Coat: Acrolon Ultra or Hi-Solids Polyurethane. DFT 2.0 to 4.0 mils.
 - e. Total DFT: 5.0 to 9.0 mils.
 - f. Finish Color: As indicated on the drawings or color schedule.
2. Interior, Non-Immersion
 - a. System Type: Epoxy.
 - b. Surface Preparation: SSPC SP 16.

- c. Primer: Macropoxy 646. DFT 3.0 to 5.0 mils.
- d. Finish Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
- e. Total DFT: 6.0 to 10.0 mils.
- f. Finish Color: As indicated on the drawings or color schedule.

C. CONCRETE

1. Exterior, Below Grade

- a. System Type: Coal tar epoxy.
- b. Surface Preparation: SSPC-SP 13/NACE 6 with a surface profile of ICRI CSP 2 or 3. Clean and dry.
- c. Primer: None.
- d. Finish Coat: Hi-Mil Sher-Tar Epoxy. DFT 14.0 to 20.0 mils.
- e. Total DFT: 14.0 to 20.0 mils.
- f. Finish Color: Black.

2. Exterior, Above Grade

- a. System Type: Elastomeric Acrylic
- b. Surface Preparation: SSPC-SP 13/NACE 6 with a surface profile of ICRI CSP 2 or 3. Clean and dry.
- c. Primer: Loxon XP. Spreading Rate 90 to 115 sf/gal.
- d. Finish Coat: Loxon XP. Spreading Rate 90 to 115 sf/gal.
- e. Finish Color: As indicated on the drawings or color schedule.

3. Immersion, Potable Water – NOT USED

4. Immersion, Wastewater

- a. System Type: Epoxy.
- b. Surface Preparation: SSPC-SP 13/NACE 6 with a surface profile of ICRI CSP 2 or 3.
- c. Filler: Fill bug holes, air pockets and other voids with Steel-Seam FT910.
- d. Primer: Cor Cote SC. DFT 20.0 to 30.0 mils.

- e. Finish: Cor Cote SC. DFT 20.0 to 30.0 mils.
- f. Total DFT: 40.0 to 60.0 mils. Finish Color: As indicated on the drawings or color schedule.

*Can be applied in one coat application. Where flexibility is required, use SherFlex Elastomeric Polyurethane at 60.0 to 100.0 mils total DFT over an epoxy primer.

5. Interior

- a. System Type: Epoxy.
- b. Surface Preparation: SSPC-SP 13/NACE 6 to achieve a surface profile of ICRI CSP 2 or 3.
- c. Primer: Pro-Industrial Waterborne Catalyzed Epoxy. DFT 2.0 to 4.0 mils. Roll or backroll.
- d. Finish Coat: Pro-Industrial Waterborne Catalyzed Epoxy. DFT 3.0 to 4.0 mils.
- e. Total DFT: 5.0 to 8.0 mils.
- f. Finish Color: As indicated on the drawings or color schedule.

6. Interior Concrete Floors – Previously Coated

- a. Surface Preparation: SSPC-SP 13/NACE 6 to remove existing coating to bare concrete and achieve a surface profile of ICRI CSP 2 or 3.
- b. Primer: Armorseal 1000 HS. DFT 3.0 to 5.0 mils.
- c. Non-slip: Anti-slip texture.
- d. Finish Coat: Armorseal 1000 HS. DFT 3.0 to 5.0 mils.
- e. Total DFT: 6.0 to 10.0 mils.
- f. Finish Color: As indicated on the drawings or color schedule.

D. COATING SYSTEMS FOR SECONDARY CONTAINMENT

1. Chemical Storage Containment Area:*

- a. System Type: High-solids flake filled hybrid novolac epoxy.
- b. Surface Preparation: SSPC-SP 13/NACE 6 with a surface profile of ICRI CSP 4 or 5.
- c. Primer: Corobond 100. DFT 4.0 to 6.0 mils.

- d. Fill bug holes, air pockets and other voids with Steel-Seam FT910.
- e. Intermediate Coat: Cor-Cote HCR FF. DFT 15.0 to 20.0 mils.
- f. Finish Coat: Cor-Cote HCR FF. DFT 15.0 to 20.0 mils.
- g. Total DFT: 34.0 to 46 mils.
- h. Finish Color: As indicated on the drawings or color schedule.

*Verify resistance to stored commodities and anticipated traffic load PRIOR to installation.

2. Acetic Acid Exposure:

- a. System Type: Flake filled styrene free vinyl ester.
- b. Surface Preparation: SSPC-SP 13/NACE 6 with a surface profile of ICRI CSP 3 to 5.
- c. Primer and Patch: If surface deterioration presents an unacceptably rough surface, prime with Corobond Vinyl Ester Primer DFT 3.5 to 4.5 mils. Patch and resurface with Poly-Glass Putty.
- d. Intermediate Coat: Magnalux 404 FF Vinyl Ester Coating. DFT 20.0 to 30 mils
- e. Finish Coat: Magnalux 404 FF Vinyl Ester
- f. Coating. DFT 20.0 to 30 mils
- g. Total DFT: 40.0 to 60.0 mils
- h. Finish Color: Off White.

E. CONCRETE BLOCK & POROUS MASONRY

1. Exterior

- a. System Type: Elastomeric Acrylic.
- b. Surface Preparation: SSPC-SP 13/NACE 6. Clean and dry.
- c. Primer: Loxon XP. Spreading Rate 90 to 115 sf/gal.
- d. Finish Coat: Loxon XP. Spreading Rate 90 to 115 sf/gal.
- e. Finish Color: As selected by Architect from manufacturer's standard colors.

2. Interior

- a. System Type: Cementitious Acrylic/epoxy
- b. Surface Preparation: SSPC-SP 13/NACE 6. Clean and dry.
- c. Primer: Cement Plex 875. Spreading rate 80 to 100 sq. ft/gal.
- d. Intermediate Coat: Pro-Industrial Waterborne Catalyzed Epoxy. DFT 2.0 to 4.0 mils.
- e. Finish Coat: Pro-Industrial Waterborne Catalyzed Epoxy. DFT 3.0 to 4.0 mils.
- f. Total DFT: 5.0 to 8.0 mils plus filler.
- g. Finish Color: As selected by Architect from manufacturer's standard colors.

3. Interior – Previously Coated Block (Omit Block Filler)

- a. System Type: Waterbased Catalyzed Epoxy
- b. Surface Preparation: Scuff-sand or mechanically abrade existing finish. Clean and dry.
- c. First Coat: Pro-Industrial Waterborne Catalyzed Epoxy. DFT 2.0 to 4.0 mils.
- d. Finish Coat: Pro-Industrial Waterborne Catalyzed Epoxy. DFT 3.0 to 4.0 mils.
- e. Total DFT: 5.0 to 8.0 mils.
- f. Finish Color: As selected by Architect from manufacturer's standard colors.

F. PLASTER AND WOOD

1. Interior or Exterior

- a. System Type: Acrylic.
- b. Surface Preparation: Clean and dry.
- c. Primer: PrepRite ProBlock Interior/Exterior Latex Primer/Sealer. DFT 1.0 to 1.5 mils.
- d. Intermediate Coat: Pro-Industrial High Performance Acrylic. DFT 2.5 to 4.0 mils.

- e. Finish Coat: Pro-Industrial High Performance Acrylic. DFT 2.5 to 4.0 mils.
- f. Total DFT: 6.0 to 9.5 mils.
- g. Finish Color: As selected by Architect from manufacturer's standard colors.

G. ARCHITECTURAL GYPSUM BOARD

- 1. Interior Exposed:
 - a. System Type: Latex/Vinyl-Acrylic.
 - b. Surface Preparation: Clean and dry.
 - c. Primer: Promar 200 Interior Latex Primer. DFT 1.0 to 1.5 mils.
 - d. Intermediate Coat: Promar 200 Eggshell. DFT 1.5 to 2.0 mils.
 - e. Finish Coat: Promar 200 Eggshell. DFT 1.5 to 2.0 mils.
 - f. Total DFT: 4.0 to 5.5 mils.
 - g. Finish Color: As selected by Architect from manufacturer's standard colors.

H. INSULATED PIPE

- 1. Interior
 - a. System Type: Acrylic.
 - b. Surface Preparation: Clean and dry.
 - c. Primer: Pro Industrial Pro-Cryl Universal Primer. DFT 2.0 to 4.0 mils.
 - d. Finish Coat: Pro Industrial High
 - e. Performace Acrylic. DFT 2.5 to 4.0 mils.
 - f. Total DFT: 4.5 to 8.0 mils.
 - g. Finish Color: As indicated on the drawings or color schedule.

I. COATING SYSTEMS FOR DUCTILE OR CAST IRON - PIPE, PUMPS, AND VALVES

- 1. Exterior, Non-Immersion
 - a. System Type: Epoxy/epoxy/urethane.

- b. Surface Preparation: NAPF 500-03-04 with the exception that ALL rust and mold coating be removed. Only tightly adherent annealing oxide may remain..
- c. Primer: Macropoxy 646. DFT 3.0 to 5.0 mils.
- d. Intermediate Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
- e. Finish Coat: Ultra or Hi-Solids Polyurethane. DFT 2.0 to 4.0 mils.
- f. Total DFT: 8.0 to 14.0 mils.
- g. Finish Color: As indicated on the drawings or color schedule.

*Copoxy Shop Primer and Corothane I Galvapac Zinc Primer are also acceptable.

2. Exterior, Below Grade

- a. System Type: Coal tar epoxy.
- b. Surface Preparation: NAPF 500-03-04 with the exception that ALL rust and mold coating be removed. Only tightly adherent annealing oxide may remain.
- c. Primer: None.
- d. Finish Coat: Hi-Mil Sher-Tar Epoxy. DFT 14.0 to 20.0 mils.
- e. Total DFT: 14.0 to 20.0 mils.
- f. Finish Color: Black.

3. Interior, Non-Immersion

- a. System Type: Epoxy/epoxy.
- b. Surface Preparation: Surface Preparation: NAPF 500-03-04 with the exception that ALL rust and mold coating be removed. Only tightly adherent annealing oxide may remain..
- c. Primer: Macropoxy 646. DFT 3.0 to 5.0 mils.
- d. Intermediate Coat: Macropoxy 646. DFT 3.0 to 5.0 mils.
- e. Finish Coat: Macropoxy 646 DFT 3.0 to 5.0 mils.
- f. Total DFT: 9.0 to 15.0 mils.
- g. Finish Color: As indicated on the drawings or color schedule.

*Copoly Shop Primer and Corothane I Galvapak Zinc Primer are also acceptable.

4. Interior, Immersion, Wastewater

- a. System Type: Epoxy/epoxy/epoxy.
- b. Surface Preparation: NAPF 500-03-04 with the exception that ALL rust and mold coating be removed. Only tightly adherent annealing oxide may remain.
- c. Primer: Sher-Glass FF: DFT 8.0 to 12.0 mils.
- d. Finish Coat: Sher-Glass FF: DFT 8.0 to 12.0 mils
- e. Total DFT: 16.0 to 24.0 mils.

*Spray apply Dura-Plate UHS for one or two coat application. OAP technology strongly recommended. COAL TAR EPOXY SHALL NOT BE USED.

3.6 COLOR SCHEDULE AND PIPING COLOR CODE

- A. To facilitate identification of piping colors, follow the Color Schedule located at the end of this specification.

3.7 COLOR CODED AND MARKED PIPING

- A. All exposed piping shall be painted, color coded, and marked.
 1. Piping in exposed trenches shall be considered exposed.
 2. Markers shall be in accordance with the sections entitled "Mechanical Identification" and "Process Mechanical Identification."
 3. Printing on markers shall be of sufficient size and style as reviewed by Engineer.
 4. A flow arrow shall be installed with each pipe marker at a minimum spacing of 10 ft.
 5. Where two colors do not have sufficient contrast to easily differentiate between them, a six-inch band of contrasting color shall be on one of the pipes at 36 inch intervals.
- B. On fiberglass, plastic, stainless steel, copper pipe, or other uncoated piping, a combination of wide banding tape and narrow banding tape shall be used for the pipe color and band.
- C. Pipe: Color code all pipes, including insulated pipe, in accordance with the schedule given below. Where applicable, colors shall comply with the specifications described in

Section 3, "Color Definitions" of ANSI Z53.1. Other colors shall be selected by the Engineer or Architect in accordance with this specification.

- D. Stripes where required shall consist of 6-inch wide bands completely around the pipe located 36 inches on centers. On pipe runs less than 36 inches in length, one color band shall be located at the center of the run.

E. Pipe Labels

1. Legends: After other painting of pipe work has been completed as provided for above, label all pipe work with stenciled legends. Legends shall be descriptive of the function of the pipe, such as "ACID." Provide two legends, one legend on each side of the pipe, at a suitable location along each pipe run. For long runs of pipe, provide legends at intervals not exceeding 20 feet. Locate the legend on the pipe so that it will be in direct line of vision. Legend may be omitted from one side if view is obstructed from that side. Where the flow in a pipe shall be at all times in one direction only, then a flow arrow shall be placed in front of each legend on the pipe. The lettering and arrows shall be cut neatly into stencils, the arrows being the same height as the letters. The size of lettering shall be as follows:

Outside Diameter of Pipe or Covering	Size of Letters
3/4" to 1-1/4"	1/2"
1-1/2" to 2"	3/4"
2-1/2" to 6"	1-1/4"
8" to 10"	2-1/2"
Over 10"	3-1/2"

2. Tag: For pipes smaller than 3/4 inch in outside diameter, use a laminated plastic or aluminum tag with the lettering etched or stamped and filled in with black or contrasting enamel.
3. Legends and Flow Arrows: The legends and flow arrows shall be stenciled with approved black or contrasting stencil paint. The above outline of intent designates the general extent of the identification work and is not exclusive of other similar work such as identification of pumps and other equipment as may be directed by the Engineer. Following the completion of the work under this item, deliver to the Owner two sets of all stencils used.
4. Equipment Labels: Where specified in these Contract Documents or directed by the Engineer, paint stencil legends, in the same manner as a pipe of appropriate

size on the individual units of equipment such as blowers, pumps, collector drives, compressors, silencers etc. All push buttons, starters, switches, etc., when remote from the equipment controlled and/or power packs, shall have labels of the engraved plastic type affixed to or adjacent to the remote switch, push button, starter, etc.

Color Schedule

Material	Color
<u>Hazardous</u>	
Acid	Yellow with Black Stripes
Chlorine	Yellow
Ferric Chloride	Yellow with Red Stripes
Hydraulic Fluid Piping	Yellow with Blue Stripes
Lime Slurry	Yellow with Green Stripes
<u>Air Systems</u>	
Instrument Air	Green with White Stripes
Process Air	Green
Vacuum	Green with Red Stripes
Flammable	
Digester Gas	Orange
Fuel Oil	Orange with Blue Stripes
Natural Gas	Red
<u>Process Water</u>	
Plant Water	Dark Blue
Seal Water	Dark Blue
Wash Water (High Pressure)	Dark Blue with White Stripes
Cooling Water	Dark Blue
<u>Sludge</u>	
Blended Sludge	Tan with Blue Stripes
Digested Sludge	Tan with Green Stripes
Primary Sludge	Tan with Orange Stripes
Return or Recirculated Sludge	Tan
Transfer Piping	Tan with Red Stripes
Waste Activated Sludge	Tan with Black Stripes
<u>Vents</u>	
Digester Gas Vents	Aluminum with Orange Stripes

Fuel Oil Vents	Aluminum with Blue Stripes
Sanitary Vents	Aluminum with Black Stripes
Other Vents	Aluminum with Green Stripes

Process Piping

Heating and Heat Recovery Piping (Steam)	Gray with Red Stripes
Supernatant, Decant, or Filtrate Overflow	Gray
Raw Sewage (Sanitary)	Black

Miscellaneous

Electrical Conduit	Aluminum*
Oxygen	White
Potable Water	Light Blue
Hot Water Supply	Yellow with Red Stripes
Hot Water Return	Yellow with Green Stripes
Roof Drains	Gray with Blue Stripes

*Where electrical conduit is exposed in a finished room or area, the conduit shall be painted to match room finish.

3.8 UNUSED PAINT DISPOSAL

- A. The Contractor shall dispose of any paint left unused at the completion of the work offsite at an approved facility. No remaining paint shall be given to the Owner for touch-up paint. Color charts from the paint supplier noting paint colors used during the Work shall be provided to the Owner to purchase any touch-up paint required after completion of the Work.

SECTION 09 96 59

PROTECTIVE LINING FOR CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope

1. Contractor shall provide all labor, materials, equipment and incidentals as specified, shown, and required to furnish, install, and place into satisfactory service the protective liner for concrete Work.
2. Install protective liner where indicated on the Contract Drawings.
3. Types of protective lining for concrete Work required include, but are not necessarily limited to, the following:
 - a. Trowelable, rapid-setting, cementitious repair mortar
 - b. Trowelable, fast-setting, epoxy- modified resurfacer (thin overlay)
 - c. Corrosion-resistant, trowel-applied, aggregate-reinforced epoxy mortar (basecoat)
 - d. Corrosion-resistant, high-build epoxy glaze coat (topcoat)
 - e. Miscellaneous materials.
4. Cleaning, surface preparation, lining application, and thicknesses shall be as specified herein and shall meet or exceed the lining manufacturer's recommendations. When the manufacturer's minimum recommendations exceed the specified requirements, Contractor shall comply with the Manufacturer's minimum recommendations.

B. Coordination:

1. Coordinate surface preparation of substrates to avoid later difficulty or delay in performing the Work of this Section.
2. Review installation procedures under other Sections and coordinate the installation of items that must be installed prior to application of the protective lining.
3. Substrate surface preparation and lining application, including concrete resurfacing, to be completed by manufacturer's approved Applicator.

4. The Contractor shall coordinate with Engineer regarding the availability of work areas, completion times, safety, access and other factors which can impact plant station operations.

1.2 REFERENCES

- A. This Section contains references to the governing standards and documents listed below. They are a part of this Section as specified and modified; the current version shall apply unless otherwise noted. In case of conflict between the requirements of this section and those of the listed documents, the more stringent of the requirements shall prevail.

1. American Concrete Institute, (ACI)
 - a. ACI 224.1R – Causes, Evaluation and Repair of Cracks in Concrete Structures
 - b. ACI 301 – Specifications for Structural Concrete
 - c. ACI 308R – Guide to Curing Concrete
 - d. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary
 - e. ACI 515 – A Guide to the use of Waterproofing, Dampproofing, Protective, and Decorative Barrier Systems for Concrete
 - f. ACI 546.R – Concrete Repair Guide
 - g. ACI 546.3R – Guide for the Selection of Materials for the Repair of Concrete
2. ASTM International, (ASTM)
 - a. ASTM C 868 – Standard Test Method for Chemical Resistance of Protective Linings
 - b. ASTM C 1583/1583M – Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)
 - c. ASTM D 2794 – Standard Test Method for Resistance of Organic Linings to the Effects of Rapid Deformation (Impact)
 - d. ASTM D 4060 – Standard Test Method for Abrasion Resistance of Organic Linings by the Taber Abraser
 - e. ASTM D 4285 – Standard Test Method for Indicating Water or Oil in Compressed Air

- f. ASTM D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
 - g. ASTM D 4414 – Standard Practice for Measurement of Wet Film Thickness by Notch Gages
 - h. ASTM D 6944 Standard Test Method for Measuring Humidity with a Psychrometer
 - i. ASTM D 7682 – Standard Test Method for Replication and Measurement of Concrete Surface Profiles Using Replica Putty
 - j. ASTM F 1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
 - k. ASTM F 2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
 - l. ASTM F 2414 – Standard Practice for Sealing Sewer Manholes Using Chemical Grouting
3. International Concrete Repair Institute, (ICRI)
- a. Guideline No. 310.1R – Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
 - b. Guideline No. 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealer, Linings, and Polymer Overlays
4. NACE International, (NACE)
- a. NACE Publication 6D-173 – A Manual for Painter Safety
 - b. NACE SP0188 – Standard Practice for Discontinuity (Holiday) Testing of Protective Linings
 - c. NACE SP0892 – Standard Practice for Coatings and Linings over Concrete for Chemical Immersion and Containment Service
 - d. NACE No. 6/SSPC-SP13 – Surface Preparation of Concrete
5. Occupational Safety and health Administration, (OSHA)
- a. Safety and health Standards (29 CFR 1910/1926)
6. SSPC: The Society for Protective Linings, (SSPC)
- a. SSPC-SP13/NACE No. 6 – Surface Preparation of Concrete

- b. SSPC-Guide 12 – Guide for Illumination of Industrial Painting Projects
- 7. Standard Practice for the Rapid Evaluation of Coatings and Linings by Severe Wastewater Analysis Test, (S.W.A.T.)
 - a. Corrosion Testing Laboratories, Inc., Newark, DE, USA. (www.corrosionlab.com). Contact: Brad Krantz 302-454-8200.
 - b. RAE Engineering and Inspection, LTD., Edmonton, Alberta, CANADA. (www.raeengineering.ca) Contact: Linda Gray 780-440-9391.
- B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of receipt of Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents, the last version of the document before it was discontinued.

1.3 QUALITY ASSURANCE

A. Applicator Qualifications

- 1. Contractor shall be a qualified Applicator by the corrosion protection lining manufacturer prior to bid date. Submit proof of acceptability of Applicator by manufacturer to Engineer.
- 2. Installation equipment shall be acceptable to the protective lining manufacturer.
- 3. Applicator to establish quality control procedures and practices to monitor phases of surface preparation, storage, mixing, application, and inspection throughout the duration of the project. Contractor to provide a fulltime, on-site person whose dedicated responsibilities will include quality control of the corrosion protection linings.
- 4. Applicator's quality control procedures and practices must include the following items:
 - a. Training of personnel in the proper surface preparation requirements.
 - b. Training of personnel in the proper storing, mixing, and application and quality control testing of the linings.

B. Mock-Ups:

- 1. Prior to the installation of the corrosion protection lining and auxiliary system components, but after Engineer's approval of the Samples and Shop Drawings, install 150 square foot stepped-back mock-ups of the systems showing each system component in an area selected by Engineer to show representative installation of the Work.
- 2. Engineer shall approve the mock-up before the start of Work.

3. Retain and protect mock-ups during construction as one standard for judging completed corrosion protection lining Work. Do not alter mock-ups after approval by Engineer.
 - a. Finished Work, in compliance with visual qualities of mock-ups, that fails other on-Site quality control testing procedures shall be replaced by Contractor at no charge to the Owner.
4. Contractor shall build as many mock-ups as required to achieve Engineer's acceptance of the corrosion protection lining.
5. The approved mock-up shall be considered the acceptable minimum standard of quality.
6. Any corrosion protection lining Work that proceeds without approved mock-ups will not be accepted by the Engineer and removed at no cost to the Owner.

C. Pre-Installation Conference:

1. Before erecting mock-ups Contractor, Installer and technical representative of the corrosion protection lining manufacturer shall meet on-site with Engineer to discuss approved products and workmanship to ensure proper application of the corrosion protection lining components and substrate preparation requirements.
2. Review foreseeable methods and procedures related to the corrosion protection lining of coating Work including but not necessarily limited to the following:
 - a. Review Project requirements and the Contract Documents.
 - b. Review required submittals, both completed and yet to be completed.
 - c. Review status of substrate Work, including approval of surface preparations and similar considerations.
 - d. Review requirements of on-Site quality control testing and requirements for preparing Site Quality Control Report as specified herein.
 - e. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
 - f. Review required inspection and testing.
 - g. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
 - h. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
 - i. Review procedures required for the protection of the corrosion protection lining during the remainder of the construction period.

3. Record the discussions of the Pre-Installation Conference and the decisions and agreements or disagreements reached, and furnish a copy of the minutes to each party attending. Record any revision or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them.
 4. Reconvene the conference at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.
- D. Performance Criteria: The surfaces to receive the protective lining shall be capable of withstanding under constant exposure to raw wastewater, permeation from hydrogen sulfide and other sewer gases, and attack from organic acids generated by microbial sources. Products must have sufficient field history and accelerated laboratory testing to substantiate product viability for these exposures.
- E. Source Quality Control: Provide each component of protective lining produced by a single manufacturer, including recommended repair mortar, repair overlay (resurfacer), base coat and topcoat materials.
- F. Reference Standards: Comply with applicable provisions and recommendations of all standards listed in Section 1.2 except as otherwise shown or specified.
- G. Protective Linings system specified are as manufactured by Tnemec Company, Inc., Kansas City, MO (816) 483-3400. Specified system is the minimum standard of quality for this project. Request for material substitutions shall be in accordance with requirements of the project specifications.

1.4 SUBMITTALS

- A. Submit the following in accordance with Specification entitled "Submittal Procedures".
- B. Shop Drawings: Submit for approval prior to commencing any Work:
1. Product Data Sheets: Copies of current technical data for each component specified and applied as outlined in this Section.
 2. Material Safety Data Sheets: Copies of current MSDS for any materials brought on-site including all clean-up solvents, repair or resurfacing mortars and lining materials.
 3. Qualification Data: Approved Installer Training Certificates from manufacturer.
 4. Performance Testing Reports: Copies of test data for the entire physical, chemical, and permeation properties listed herein and as outlined within this Section.
 5. Installation Instructions: Manufacturer's written installation instructions for the materials specified in this Section.

6. Construction Details: Copies of manufacturer's computer generated standard lining details for specified materials, including: leading edge termination, metal embedment in concrete, joint detail, wall-to-slab detail, pipe termination detail, and any other detail at the request of the Engineer.
 7. Maintenance Manual: Upon completion of the Work, submit five copies of corrosion protection lining manufacturer's written instructions for recommended maintenance practices. Include the following information:
 - a. Product name and number.
 - b. Name, address, e-mail address and telephone number of manufacturer and local representative.
 - c. Detailed procedures for routine maintenance and cleaning.
 - d. Detailed procedures for repairs.
 8. Product Substitution: The specified corrosion protection lining is the minimum standard of quality for this project. Equivalent materials of other manufacturers may be substituted only by approval of Engineer. Requests for material substitutions shall be in accordance with requirements of the project specification.
 - a. Manufacturers of "or equal" products shall provide direct property comparison with the materials specified in addition to complying with all other requirements of these Specifications. "Or equal" products shall employ the same generic materials and system components as the corrosion protection lining specified. "Or equal" products shall provide equivalent performance as the specified corrosion protection lining.
 - b. Bidders desiring to use corrosion protection lining other than those specified shall submit proposed system with their proposal at the time of bid, together with the information required herein, and indicate the sum which will be deducted from the base bid should alternate materials be accepted.
- C. Jobsite Reports: Submit at the completion of Work
1. Daily Reports: Include surface preparation, substrate conditions, ambient conditions application procedures, lining materials applied, material quantities, material batch number(s), description of work completed and location thereof.
 2. Quality Control Reports: Include all quality control testing and physical specimens.
 3. Contractor shall maintain a copy of records until the expiration of the specified warranty period.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials:

1. Deliver material in manufacturer's original, unopened and undamaged packages.
2. Clearly identify manufacturer's, brand name, contents, color, batch number, and any personal safety hazards associated with the use of or exposure to the materials on each package.
3. Packages showing indications of damage that may affect condition of contents are not acceptable.

B. Storage of Materials:

1. Materials shall be stored in accordance with manufacturer's recommendations in enclosed structures and shall be protected from weather and adverse temperature conditions. Flammable materials shall be stored in accordance with state and local codes. Materials exceeding storage life as defined by the manufacturer shall be removed promptly from the site. Store all materials only in area or areas designated by the Engineer solely for this purpose.
2. Store in original packaging under protective cover and protect from damage.
3. Stack containers in accordance with manufacturer's recommendations.

C. Handling of Materials: Handle materials in such a manner as to prevent damage to products or finishes.

1.6 JOB CONDITIONS

A. Environmental Requirements:

1. Proceed with corrosion protection lining Work only when temperature and moisture conditions of substrates, air temperature, relative humidity, dew point and other conditions comply with the corrosion protection lining manufacturer's written recommendations and when no damaging environmental conditions are forecasted for the time when the material will be vulnerable to such environmental damage. Record all such conditions and include in final Site Quality Control Report.
2. Maintain substrate temperature and ambient temperature before, during and after installation above 50°F (10°C) and rising in accordance with protective lining material manufacturer's instructions.
3. Provide adequate ventilation during instillation and full curing periods of the protective lining.
4. Protective Lining shall not be applied when ambient air temperature is within 5°F (3°C) of the dew point and falling.

5. Protective Lining shall not be applied when relative humidity is outside of material manufacturer's recommendations. Do not prepare surfaces or apply materials in rain, snow, fog, mist, or otherwise inclement weather as per material manufacturer's instructions.
- B. Dust and Contaminants: Protect work and adjacent areas from excessive dust and airborne contaminants during protective lining application and curing. Schedule Work to avoid excessive dust and airborne contaminants.

1.7 WARRANTY

- A. Protective Lining Manufacturer shall warranty its products as free from material defects for a minimum period of three (3) years. Provide associated Warranty Certificate.
- B. Contractor shall warranty the installed protective lining system as free from workmanship defects for a minimum period of three (3) years.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Protective Lining shall be comprised of: 1) concrete repair mortar, where required and directed by Engineer in field, 2) epoxy resurfacer, 3) trowel-applied, aggregate-reinforced epoxy mortar (basecoat), and 4) epoxy glaze (topcoat).
 1. Cementitious Repair Mortar: Trowelable grade, rapid-setting, cementitious repair mortar when concrete is deteriorated greater than a depth of 1/4-inch and when recommended by the Manufacturer to rehabilitate and restore concrete and provide level substrate for application of the protective lining; or
 2. Epoxy Resurfacer: Epoxy-polymer modified cementitious resurfacer (thin overlay) applied to new or existing concrete to a depth up to 1/4-inch. Repair new or existing concrete to fill all bugholes, surface imperfections and provide a uniform, level substrate for application of the protective lining; and
 3. Trowel-applied, aggregate-reinforced epoxy mortar (basecoat) to provide a chemical, permeation, and abrasion resistant protective lining against physical and chemical attack phenomena typically associated with municipal wastewater headspace conditions; and
 4. Epoxy glaze coat (topcoat) to provide enhanced chemical, permeation, and abrasion resistance.
- B. Contractor shall provide all accessory components such as polysulfide sealants, and curing compounds, as recommended by the manufacturer for maximum protective lining adhesion to substrate, and long-term service performance.

C. Cementitious Repair Mortar:

1.	Properties:	Tnemec Series 217 MortarCrete
a.	Minimum Thickness:	1/4 inches
b.	Maximum Thickness:	2.0 inches
c.	Application Time	
d.	Initial set at 75°F:	60 min
e.	Final set at 75°F:	90 min
f.	Bond Strength (ASTM C 1583)	
g.	Applied at 1/4" to Concrete:	Concrete Failure
h.	Applied at 2.0" to Concrete:	Concrete Failure
i.	Compressive Strength (ASTM C 579)	
j.	16 hours:	8,670
k.	28 days:	10,650 psi
l.	Curing Requirements (ACI 308R) Method: Wet- or Membrane-cure	
m.	Duration:	1 hour
n.	Hydration (TDR Testing):	6 hours
o.	Drying Shrinkage (ASTM C 596):	0.0%
p.	Linear Shrinkage (ASTM C 531):	0.022%
q.	Thermal Expansion (ASTM C 531):	7.46 x 10 ⁻⁶ in/in/°F
2. Cementitious repair mortar shall be a rapid-setting, non-shrinking resurfacing material capable of spray-transfer. Material shall have similar CLTE properties as concrete.

D. Epoxy Cementitious Resurfacer:

1.	Properties:	Tnemec Series 218 MortarClad
a.	Minimum thickness:	1/16 inch
b.	Maximum thickness:	1/2 inch

- c. Application Working Time at 75°F: 60 min
- d. Maximum Recoat Window: Unlimited
- e. Minimum Substrate Temperature: 40°F
- f. Bond Strength (ASTM D 7234)
Applied at 1/16" to Concrete: Concrete Failure
- g. Compressive Strength (ASTM C 579): 7,100 psi
- h. Curing Requirements (ACI 308)
Method: Ambient Cure
Duration: 15 hours
- i. Flexural Strength (ASTM C580): 1,290 psi
- j. Slant Shear (ASTM C882): 1,040 psi
- k. Splitting Tensile (ASTM C496): 640 psi

2. Epoxy cementitious resurfacer shall be an epoxy-modified, aggregate reinforced material for surfacing, patching and filling voids and bugholes in concrete. The material shall be suitable for the application down to 1/16 inch thickness and be capable of spray-transfer.

E. Epoxy Lining, Aggregate-Reinforced Epoxy Lining (basecoat):

1. Properties: Tnemec Series 434 Perma-Shield H2S
 - a. Application Time at 75°F: 30 min
 - b. Color: Beige
 - c. Maximum Dry Film Thickness (DFT): 125 mils
 - d. Severe Wastewater Analysis Test (S.W.A.T.)
Initial EIS Impedance (Log Z0.01 Hz Ω cm2): 10.7
Final EIS Impedance (Log Z0.01 Hz Ω cm2): 9.1
S.W.A.T. Results with Epoxy Glaze Topcoat
Initial EIS Impedance (Log Z0.01 Hz Ω cm2): 11.3
Final EIS Impedance (Log Z0.01 Hz Ω cm2): 10.8
 - e. Bond Strength (ASTM D 7234)
Bare Concrete/Series 434: Concrete Failure
Bare Concrete/Series 218/Series 434: Concrete Failure
 - f. Chemical Resistance (ASTM C 686)
25% H2SO4, 100 days, 100°F: No effect

g.	Compressive Strength (ASTM D 695):	12,331 psi
h.	Flexural (ASTM C 580) Strength: Modulus of Elasticity:	3,200 psi 1.1 x 10 ⁶ psi
i.	Impact (ASTM D 2794)	160 in.-lbs.
j.	Shrinkage (ASTM C 531):	-0.013%
k.	Tensile Strength (ASTM D 307): Thermal Expansion Linear Coefficient (ASTM C 531):	2,030 psi 6.3 x 10 ⁻⁵ in/in/°F
l.	Water Absorption (ASTM C 413):	0.15%
m.	Water Vapor Transmission	
n.	(ASTM E 96, Procedure D):	0.27 perms
2. Epoxy Lining shall be a 100% solids, aggregate-reinforced, trowel-applied epoxy polymer protective barrier material specifically designed to protect concrete and steel surfaces in severe wastewater environments, including associated abrasive physical attack and chemical attack from sewer gases and organic acids generated by microbial sources.
 3. Epoxy Lining shall be capable of achieving the specified thickness in a single coat application.

F. Epoxy Lining, Glaze Protective Lining (topcoat):

1.	Properties:	Tnemec Series 435 Perma-Glaze
a.	Application Time at 75°F:	30 min
b.	Color:	Gray
c.	Minimum Dry Film Thickness (DFT):	15 mils
d.	Maximum Dry Film Thickness (DFT):	20 mils
e.	Severe Wastewater Analysis Test (S.W.A.T.) Initial EIS Impedance (Log Z0.01 Hz Ω cm ²): Final EIS Impedance (Log Z0.01 Hz Ω cm ²): Optical Microscopy: Δ Tensile Strength: Δ Flexural Strength:	11.3 11.1 No more than 9% No more than 19% No more than 6%
f.	Bond Strength (ASTM D7234) Bare Concrete/Series 435: Bare Concrete/Series 218/Series 435:	Concrete Failure Concrete Failure

	Bare Concrete/Series 434/Series 435:	Concrete Failure
g.	Chemical Resistance (ASTM C686) 25% H2SO4, 100 days, 100°F:	No effect
h.	Compressive Strength (ASTM D695):	9,427 psi
i.	Elongation (ASTM D638):	14.1%
j.	Flexural (ASTM D790) Strength: Modulus of Elasticity:	3,289 psi 3.0 x 10 ⁵ psi
k.	Tensile Strength (ASTM D2370):	2,053 psi
l.	Water Absorption (ASTM C413):	0.07%
m.	Water Vapor Transmission (ASTM D1653, Method B, Condition C):	0.243 perms

G. Product and Manufacturer:

1. Materials specified are those that have been evaluated for the specific service. Products of Tnemec Company, Inc. (816-483-3400) are listed to establish a standard of performance and quality. Equivalent materials of other manufacturers may be submitted on written approval of the Engineer. As part of the proof of equality, the Engineer will require at the cost of the Contractor, comparative laboratory tests as directed by the Engineer between the product specified and the requested substitution.
2. Requests for substitution shall include manufacturer's literature for each product giving name, product number, generic type, descriptive information, laboratory testing showing results to equal the performance criteria of the products specified herein. In addition, a list of ten projects shall be submitted in which each product has been used and rendered satisfactory service.
3. Requests for product substitution shall be made at least 10 days prior to the bid date.
4. Any material savings shall be passed to the Owner in the form of a contract dollar reduction.

PART 3 - EXECUTION

3.1 GENERAL

- A. Contractor shall provide, erect, and maintain all required hoists, scaffolding, staging and planking, and perform all access related hoisting work required to complete the Work of this Section as specified.

- B. Contractor shall cover or otherwise protect finish work or other surfaces not being coated within the scope of this Section. Contractor shall erect and maintain protective tarps, enclosures and/or masking to contain debris, including dust or other airborne particles from surface preparation or application activities. This may include the use of dust or debris collection apparatus as required at no additional cost to Owner.

3.2 INSPECTION

- A. Contractor shall examine the areas and conditions under which the protective coating Work is to be performed in accordance with NACE SP0892, Table 1 and SSPC-SP13/NACE No. 6, and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work.
- B. Contractor shall confirm the presence of a positive side waterproofing on the exterior of the concrete structure.
- C. Commencement of the Work of this Section shall indicate that the substrate and other conditions of installation are acceptable to the Contractor and his Applicator, and will produce a finished product meeting the requirements of the Specifications. All defects resulting from accepted conditions shall be corrected by Contractor at his own expense.
- D. Stopping Active Leaks: After surface cleaning, any visible leaks or other water ingress shall be reported to the Engineer. Any water infiltration through minor leaks must be stopped using a polyurethane grout manufactured by Avanti International, Webster, TX (281-486-5600), or approved equal, or other approved method in accordance with ACI 221.1R. Surface and grouting material may require additional surface preparation prior to application of protective coating.

3.3 PREPARATION

- A. Concrete surfaces to receive protective coating shall be cast with a smooth formed finish in accordance with ACI 301. Surfaces shall not be rubbed, sacked, troweled or otherwise finished in any manner that will obscure or cover the parent concrete surface with materials other than materials as specified in this Section.
- B. Allow cast-in-place concrete to cure for a minimum of 28 days at 75°F (24°C) and with adequate air movement before installing the corrosion protection lining system.
- C. All surface washing, abrasive blasting, waterjetting, grinding, patching, filling and preparation shall be completed by the Applicator in accordance with the Protective Coating Manufacturer's recommendations.
- D. Substrate: Concrete surfaces to be coated shall be free of curing compounds and form release agents, laitance and foreign particles that may inhibit bonding. Prior to start of protective coating systems application, pre-clean as required, and inspect the substrate in accordance with SSPC-SP13/NACE No. 6, Severe Service. Surface preparation procedures shall be in accordance with NACE SP0892, SSPC-SP13/NACE No. 6 and ICRI Guideline No. 310.2. Surface preparation shall expose aggregate and obtain a

uniform surface texture resembling the minimum recommended concrete surface ICRI-CSP profile.

- E. Level or grind concrete substrates to produce a uniform and smooth surface, including removal of all sharp edges, ridges, form fins, and other concrete protrusions.
- F. New Concrete Application: All voids, bugholes, and other surface depressions shall be filled with the specified epoxy-modified resurfacer, re-establishing plan finished grades and concrete planes. The thin overlay shall be applied as a continuous parge coat at a minimum 1/16 inch (1.6 mm) thickness to the entire concrete surface.
- G. Existing Concrete Application: Existing concrete structures to receive protective coating system must be capable of withstanding imposed loads. All oil, grease, waste and chemical contaminants must be removed from the surface of the concrete prior to preparation in accordance with NACE SP0892 and SSPC-SP13/NACE No. 6. Concrete surfaces must be sound and capable of supporting the Protective Lining system as determined by the engineer. Surface preparation requirement is to expose a sound, uniform surface texture confirming to the minimum recommended ICRI-CSP5. The appropriate cementitious repair mortar or epoxy cementitious resurfacer material shall be applied to the entire, prepared surface to level surface suitable for coating.
- H. Metal Application: Remove all visible contaminants per SSPC-SP1. Prepare the surfaces in accordance with SSPC/NACE surface preparation standards per the Manufacturer's instructions.

3.4 APPLICATION

- A. Protective coating systems shall be installed when ambient air and surface temperature is above 50°F. The substrate temperature shall be at least 5°F (3°C) above the dew point. Condition the material between 70-80°F (21-27°C) for 24 hours prior to use. Application when temperatures outside of this range will require written instruction from the Manufacturer and approval of the Engineer.
- B. Application in direct sunlight and/or with rising surface temperatures is not allowed, as this may result in blistering of the materials due to expansion of entrapped air or moisture in the concrete. In such cases, it will be necessary to postpone the application until later in the day when the temperature of the substrate is falling. Concrete surfaces that have been in direct sunlight should be shaded for at least 24 hours prior to application. Consult the Manufacturer for application schedule guidelines specific to temperature conditions and possible sealer application recommendations to reduce outgassing.
- C. Cementitious Repair Mortar: Cementitious repair mortar shall be used for structural repairs or surface repairs exceeding a depth 1/4 inch in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide, where required and directed by Engineer in field.
 - 1. Thickness – Minimum 1/4 inch as required to re-establish original plane.

- D. Epoxy Cementitious Resurfacer: Epoxy cementitious resurfacer shall be used for filling voids, bugholes, static cracks and joints, and for general concrete patching, and to provide a uniform, void free surface for Epoxy Lining application.
 - 1. Thickness – Epoxy lining shall be applied to a minimum thickness of 1/16 inch to the entire surface.
- E. Epoxy Lining (basecoat): Epoxy lining protective coating shall be trowel applied and cured in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide.
 - 1. Thickness – Epoxy lining shall be applied to a thickness of 125 mils (1/8" inch) dry film thickness to the entire surface.
- F. Epoxy Glaze Coat (topcoat): Epoxy glaze topcoat shall be applied over the epoxy lining in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide.
 - 1. Thickness – Epoxy glaze coat shall be applied to a thickness of 15-20 mils dry film thickness over the entire epoxy lining basecoat surface.

3.5 FIELD QUALITY CONTROL, INSPECTION AND TESTING

- A. Contractor to perform the quality control procedures listed below in conjunction with the requirements of this Section.
- B. Inspect all materials upon receipt to ensure that all are supplied by the approved Manufacturer.
- C. Surface pH Testing: The pH of the concrete substrate will be measured using pH indicating papers. The pH testing is to be performed once every 50 square feet (5 square meters). Acceptable pH values shall be a minimum 9.0 as measured using color indicating pH paper with readable color calibrations and a scale at whole numbers (minimum). Use Hydriion Insta-Check Jumbo 1-12, or equal. The paper shall be touched to the surface once using moderate gloved finger pressure. The surface shall not be wiped or moved laterally to disturb the surface during pH testing. Following the one touch, lift the paper vertically to not "wipe" the surface. Compare the color indicated with the scale provided and record the pH. Spot check any questionable areas with a 1% phenolphthalein solution. The phenolphthalein solution shall turn bright pink on concrete.
- D. Surface Profile: Inspect and record substrate profile (anchor pattern). Surfaces shall be profiled, at a minimum, equal to the CSP roughness as recommended by the coating manufacturer in accordance with ICRI Guideline 310.2 and SSPC-SP13/NACE No. 6.
 - 1. Perform replication of the concrete surface profile every 500 square feet (46 square meters) using replica putty in accordance with ASTM D7682. Submit replications to the Engineer as part of the Jobsite Reports.

- E. Measure and record ambient air temperature once every two hours of each work shift using a thermometer and measure and record substrate temperature once every two hours using an infrared or other surface thermometer.
- F. Measure and record relative humidity and dew point temperature every two hours of each work shift using a sling psychrometer in accordance with ASTM E 337.
- G. Provide verification of correct mixing of coating materials in accordance with the Manufacturer's instructions.
- H. Inspect and record that the "pot life" of coating materials is not exceeded during installation.
- I. Verify curing of the coating materials in accordance with the Manufacturer's instructions.
- J. Dry-Film Thickness:
 - 1. Wet-Film Thickness shall be taken every 100 square feet (9 square meters) in accordance with ASTM D 4414 and recorded.
 - 2. The Dry-Film Thickness can be determined using a surface area calculation for material consumption.
- K. High-Voltage Holiday (Spark) Testing: Upon full cure, the installed lining system shall be checked by high voltage spark detection in accordance with NACE SP0188 and the Manufacturer's printed application guide to verify a pinhole-free surface. Areas which do not pass the spark detection test shall be corrected at no cost to the Owner.
- L. Contractor is responsible for keeping the Engineer informed of all progress so that Engineer may provide additional quality control at his discretion.
- M. Inspection by the Engineer or others does not absolve the Contractor from his responsibilities for quality control inspection and testing as specified herein or as required by the Manufacturer's instructions.

3.6 ACCEPTANCE CRITERIA

- A. All surfaces shall be prepared, applied, and tested in accordance with the specification and referenced standards herein.

3.7 ADJUSTMENTS AND CLEANING

- A. At the completion of the Work, Contractor shall remove all materials and debris associated with the Work of this Section.
- B. Clean all surfaces not designated to receive protective coating. Restore all other work in a manner acceptable to Engineer.

- C. All finished protective coating shall be protected from damage until Final Acceptance of the Work. Protective coating damaged in any manner shall be repaired or replaced at the discretion of Engineer, at no additional cost to Owner.

SECTION 10 44 13

FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes fire protection cabinets for fire extinguishers.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Maintenance data.

1.4 QUALITY ASSURANCE

- A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
- B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- C. Coordinate sizes and locations of fire protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Clear Anodized Aluminum..
- B. Acrylic Bubble: One piece.

2.2 FIRE PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. J. L. Industries, Inc., a division of Activar Construction Products Group;.
 - b. Kidde Residential and Commercial Division, Subsidiary of Kidde plc;.
 - c. Larsen's Manufacturing Company;.
 - d. Or approved equal.
- B. Cabinet Construction: Nonrated, 1-hour fire rated.
 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- thick, clear anodized aluminum lined with minimum 5/8-inch-thick, fire-barrier material. Provide factory-drilled mounting holes.
- C. Cabinet Material: Clear anodized aluminum.
- D. Semi-recessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
 1. Rolled-Edge Trim: 2-1/2-inch backbend depth.
- E. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim. Provide where walls are of insufficient depth for semi-recessed cabinet installation as approved by the Engineer.
- F. Cabinet Trim Material: Clear anodized aluminum.
- G. Door Material: Clear anodized aluminum.
- H. Door Style: Full bubble with frame.
- I. Door Glazing: Molded acrylic bubble.
 1. Acrylic Bubble Color: Clear, transparent.
- J. Door Hardware: Door-operating hardware shall be made of 316 stainless steel and of proper type for cabinet type, trim style, and door material and style indicated.
- K. Accessories:
 1. Mounting Bracket: 316 stainless steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated.
 2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Engineer.

- a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER" on the face of the cabinet.
 - 1) Application Process: Manufacturers standard.
 - 2) Lettering Color: Red.
 - 3) Orientation: Vertical.

L. Finishes:

- 1. Aluminum shall be clear, anodized finish.
 - a. Exterior of cabinet, door, and trim, except for those surfaces indicated to receive another finish.
 - b. Interior of cabinet and door.

2.3 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Miter and weld joints and grind smooth.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed and prepare recesses as required by type and size of cabinet and trim style.
- B. Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- C. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
- D. Identification: Apply vinyl lettering at locations indicated.
- E. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- F. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

SECTION 10 44 16

FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.
- C. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
- C. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amerex Corporation.
 - b. Ansul Incorporated; Tyco International Ltd.
 - c. Badger Fire Protection; a Kidde company.
 - d. Buckeye Fire Equipment Company.
 - e. Fire End & Croker Corporation.
 - f. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - g. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
 - h. Larsen's Manufacturing Company.
 - i. Moon-American.
 - j. Pem All Fire Extinguisher Corp.; a division of PEM Systems, Inc.
 - k. Potter Roemer LLC.
 - l. Pyro-Chem; Tyco Safety Products.
 - m. Or approved equal.
 - 2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type ABC: UL-rated 10 lb. nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.
- C. Clean-Agent Type in Steel Container: UL-rated 1-A:10-B:C, 10-lb nominal capacity, with HFC blend agent and inert material in enameled-steel container; with pressure-indicating gage (Electronics-Safe).

2.2 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
- B. Mounting Brackets shall only be used in the event a Fire cabinet where shown on the drawings, is unable to be installed due to construction constraints. However, under no circumstances are mounting brackets to be utilized on the Ground floor without prior approval of Engineer and owner or owner's representative.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amerex Corporation.
 - b. Ansul Incorporated; Tyco International Ltd.
 - c. Badger Fire Protection; a Kidde company.
 - d. Buckeye Fire Equipment Company.
 - e. Fire End & Croker Corporation.
 - f. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - g. Larsen's Manufacturing Company.
 - h. Potter Roemer LLC.
 - i. Or approved equal.
- C. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Engineer.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.

- B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: 54 inches (1372 mm) above finished floor to top of fire extinguisher.
- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

SECTION 13 42 13

FIBERGLASS REINFORCED POLYESTER (FRP) MODULAR TYPE BUILDING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplemental Conditions and Division 1 specification sections apply to this section.
- B. Section 44 31 21 – Odor Control Systems
- C. Division 26 - Electrical

1.2 SUMMARY

- A. The Odor Control System manufacturer (section 44 31 21) shall furnish one pre-engineered, modular, molded fiberglass reinforced polyester (FRP) building, to be installed by the Contractor as specified herein and as shown on the Drawings.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications. Provide pre-engineered FRP modular buildings manufactured by a firm experienced in manufacturing FRP modular building systems that are similar to those indicated for this project and have a record of successful in-service performance.
- B. Single-Source Responsibility. The odor control system manufacturer shall obtain the FRP modular building system components from a single manufacturer.
- C. Design Criteria. The Drawings and Specifications indicate sizes, profiles, and dimensional requirements of the pre-engineered FRP modular building system. FRP building systems having equal performance characteristics with deviations from indicated dimensions and profiles may be considered, provided deviations do not change the design concept or intended performance. The burden of proof for equality is on the proposer.

1.4 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:
 - 1. Odor Control Building

1.5 SUBMITTALS

- A. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:
 - 1. All structural design calculations shall be prepared by the manufacturer and sealed by a registered professional engineer.

2. Manufacturer's literature, illustrations, specifications, and engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.
3. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
4. Electrical wiring diagrams clearly indicating the required field-wiring connections.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Building shall be as manufactured by Engineered Fiberglass Composites, or approved equal.

2.2 FRP MODULAR BUILDING SYSTEM

- A. General. Engineer, design, fabricate, and erect the pre-engineered FRP modular building to withstand loads from winds, gravity, structural movement including movement thermally induced, and to resist in-service use conditions that the building will experience, including exposure to the weather, without failure.
 1. Design Loads. Design building to withstand 135-mph wind load, 40 psf snow load, Seismic Zone 4.
- B. FRP modular building shall have the following overall dimensions: 10'0" wide x 12'0" deep x 7'6" high (minimum) with a peaked (or sloped) roof.
- C. Building shall be of one-piece molded composite construction. Walls and roof shall be integral with smooth radii for all corners. Buildings assembled from fabricated panels shall not be acceptable.
- D. Interior and exterior FRP laminate shall be constructed of polyester resin with chopped glass strand fiber reinforcement having a minimum glass content of 30 percent and minimum thickness of 1/8 inch. Laminate shall be chemically bonded to a minimum 15-mil surface gelcoat encapsulating the foam core. Surface shall have UV inhibitor and a lightly textured satin finish. Laminate shall be smooth and free from fiber pattern, roughness, or other irregularities
- E. Interior and exterior color of building to be cream.
- F. Panel core shall be rigid, closed cell, self-extinguishing foam having a minimum R-value of 14.
- G. Building shall include a molded FRP flush-fitting double door large enough for the removal of all equipment located inside or a minimum width of 3'0", whichever is

greater. Door shall have a smooth gelcoat finish. Door frame to be of FRP construction. Door shall be provided with the following items:

1. Two 5-inch-long stainless steel strap hinges.
 2. Spring-cushioned stainless steel door stop.
 3. One keyed stainless steel cylindrical lockset with two keys.
 4. Neoprene door seal gasket (weather-stripping) and door sweep.
 5. Stainless steel threshold with neoprene gasket.
 6. All door hardware and fasteners to be stainless steel.
 7. 3-inch-deep FRP drip cap over door.
- H. Provide 3-inch-wide by 1/7-inch-thick internal mounting flange with 2-inch-wide by 3/8-inch-thick sponge rubber gasket for a weathertight seal.
- I. Building shall be factory-equipped and pre-wired with the following accessories:
1. Main Circuit breaker panel, 100 amp, 480 volt, three-phase main circuit breaker, minimum 14-branch, NEMA 1. Panel shall be factory wired to feed all control panels provided by the odor control systems manufacturer.
 2. Electrical wiring, minimum No. 12 AWG THHN/THWN, in rigid Schedule 40 conduit.
 3. Two (2) interior GFCI receptacles, 20 amps, 120 volts (one below equipment mounting strut). One (1) weather-proof exterior GFCI convenience receptacle, 20 amps, 120 volts meeting NEC requirements.
 4. Toggle switch for light in weatherproof enclosure.
 5. Exhaust fan with integral gravity aluminum shutter, aluminum fan blades, FRP canopy, OSHA compliant fan guard, 585 cfm, 10-inch-diameter, wired to thermostat.
 6. Gravity FRP intake shutter with FRP frame and removable stainless steel insect screen, 10-inches x 10 inches.
 7. 1500-watt, 480-volt, 5120 BtuH wall heater with automatic reset thermal overload protection, indicator light, and built-in thermostat.
 8. Line voltage thermostat for operation of exhaust fan.
 9. Provide adequate interior LED Lighting for normal operation and maintenance of equipment located inside the building meeting Specification 26 50 00 – Lighting.

10. Provide two (2) exterior wall-packs, one on the front and back side of the building as shown in the contract drawings. All lighting will meet Specification 26 50 00 – Lighting.
 10. All equipment shall be floor mounted on a 4” concrete riser or wall mounted using stainless steel, 1” deep mounting strut.
 11. Wall penetrations (“Doghouses”) for three (3) process pipes as shown on the contract drawings.
 12. A window with a minimum size of 12” in width by 12” in height, as shown in the contract drawings.
- J. Building Walls shall be adequately reinforced to facilitate installation of control panels and pipe penetrations furnished by the odor control manufacturer at the locations shown on the drawings.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Prepare concrete floor slab in accordance with manufacturer’s instructions and coordinate with underground utilities such as floor drains. Verify that floor slab is level, true to plane, and of correct dimensions to receive the building. Provide stainless steel anchor bolts as required.
- B. Install building in accordance with manufacturer’s written instructions.
- C. Install and test building accessories for proper operation in accordance with manufacturer’s written instructions.
- D. Clean surfaces and repair any minor surface scratches in accordance with manufacturer’s instructions.

* * * * *

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following basic plumbing materials and methods to complement other Division 22 Sections.
 - 1. Pipe joining materials.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Fabricated metal equipment supports.
 - 9. Installation requirements common to plumbing specification Sections.
 - 10. Piping joint construction.
 - 11. Cutting and patching.
 - 12. Painting and finishing
- B. Pipe and pipe fitting materials are specified in piping systems sections.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. Local Building Codes
 - 2. 2009 International Building Code
 - 3. 2009 International Mechanical Code
 - 4. 2009 International Plumbing Code
 - 5. American Society of Mechanical Engineers (ASME)
 - 6. American National Standards Institute (ANSI)
 - 7. National Fire Protection Association (NFPA)
 - 8. Underwriters Laboratories (UL)
 - 9. American Society for Testing and Materials (ASTM)
 - 10. American Welding Society (AWS)
 - 11. Occupational Safety and Health Administration (OSHA)
- B. Definitions:
 - 1. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.
 - 2. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
 - 3. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

4. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
5. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
6. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
7. The following are industry abbreviations for plastic materials:
 - a. ABS: Acrylonitrile-butadiene-styrene plastic.
 - b. CPVC: Chlorinated polyvinyl chloride plastic.
 - c. PE: Polyethylene plastic.
 - d. PVC: Polyvinyl chloride plastic.
8. The following are industry abbreviations for rubber materials:
 - a. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - b. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data. Submit product data for following items:
 1. Mechanical sleeve seals.
 2. Transition fittings.
 3. Dielectric fittings.
 4. Escutcheons.

1.4 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 PIPE JOINING MATERIALS

- A. Materials and Construction:
 1. Refer to individual piping system specification Sections in Division 22 for special joining materials not listed below.
 2. Solder Filler Metal: ASTM B32.
 - a. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.
 - b. Alloy Sn50: Tin (50 percent) and lead (50 percent).
 3. Brazing Filler Metals: AWS A5.8.
 - a. BCuP Series: Copper-phosphorus alloys for general duty brazing.
 - b. BAg1: Silver alloy for refrigerant piping.
 4. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

5. Solvent Cements: Solvent cements shall have proper chemical resistance for application. Manufacturer's standard solvents complying with the following:
 - a. Acrylonitrile-Butadiene-Styrene (ABS): ASTM D2235.
 - b. Chlorinated Poly (Vinyl Chloride) (CPVC): ASTM F493.
 - c. Poly (Vinyl Chloride) (PVC): ASTM D2564.
 - d. PVC to ABS Transition: Made to requirements of ASTM D3138, color other than orange.

2.2 TRANSITION FITTINGS

A. Materials and Construction:

1. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - a. Manufacturers:
 - 1) Eslon Thermoplastics.
 - 2) Or approved equal
2. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - a. Manufacturers:
 - 1) Thompson Plastics, Inc.
 - 2) Or approved equal.
3. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - a. Manufacturers:
 - 1) Hayward
 - 2) Nibco
 - 3) Or approved equal.
4. Flexible Transition Couplings for Underground Piping Systems: ASTM C1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - a. Manufacturers:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Fernco, Inc.
 - 3) Mission Rubber Company.
 - 4) Plastic Oddities, Inc.
 - 5) Or approved equal.

2.3 DIELECTRIC FITTINGS

A. Manufacturers:

1. Capitol Manufacturing Co.
2. Central Plastics Company.
3. Eclipse, Inc.
4. Epco Sales, Inc.
5. Hart Industries
6. International, Inc.
7. Watts Industries, Inc.
8. Water Products Div.

9. Zurn Industries, Inc.
 10. Wilkins Div.
 11. Or approved equal
- B. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- C. Performance/Design Criteria:
1. Insulating Material: Suitable for system fluid, pressure, and temperature.
 2. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Materials and Construction:
1. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - a. Manufacturers:
 - 1) Capitol Manufacturing Co.
 - 2) Central Plastics Company.
 - 3) Epco Sales, Inc.
 - 4) Watts Industries, Inc.; Water Products Div.
 - 5) Or approved equal.
 2. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and stainless steel backing washers.
 - a. Manufacturers:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) Pipeline Seal and Insulator, Inc.
 - 5) Or approved equal.
 - b. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
 3. Dielectric Couplings: Stainless steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - a. Manufacturers:
 - 1) Calpico, Inc.
 - 2) Lochinvar Corp.
 - 3) Or approved equal.
 4. Dielectric Nipples: Stainless steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - a. Manufacturers:
 - 1) Perfection Corp.
 - 2) Precision Plumbing Products, Inc.
 - 3) Sioux Chief Manufacturing Co., Inc.
 - 4) Victaulic Co. of America.
 - 5) Or approved equal.

2.4 SLEEVES

A. Materials and Construction:

1. Stainless Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
2. Stainless Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, Type 316 stainless steel, plain ends.
3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with set screws.
5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
6. PVC Pipe: ASTM D1785, Schedule 40.
7. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co..
4. Or approved equal

B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

C. Materials and Construction:

1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. Materials and Construction:

1. One-Piece, Stamped Stainless Steel Type: With set screw or spring clips and chrome-plated finish.

2.7 GROUT

A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

B. Materials and Construction:

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.8 FABRICATED METAL SUPPORTS

- A. Description: Structural Steel Shapes: Stainless Steel, Type 316, ASTM A276.

2.9 GENERAL

- A. All components of like size and type shall be the product of the same manufacturer for purposes of parts interchangeability.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
- C. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
- D. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
- E. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- F. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- G. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- H. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality

3.2 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

- C. Verify that ground connections are in place and that installation of grounding described in Section “Grounding” is complete.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install plumbing fixtures and piping systems as shown on the Contract Drawings and in accordance with the manufacturer’s installation instructions.
- B. Plumbing System Installations
 - 1. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
 - a. Coordinate plumbing systems, equipment, and materials installation with other building components.
 - b. Verify all dimensions by field measurements.
 - c. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for plumbing installations.
 - d. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - e. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - f. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - g. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - h. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Owner’s Representative.
 - i. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
 - j. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
 - k. Install access panel or doors where units are concealed behind finished surfaces.
 - l. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- C. Piping Installation

1. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 22 specify piping installation requirements unique to the piping system.
2. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.
3. Install piping at indicated slope.
4. Install components having pressure rating equal to or greater than system operating pressure.
5. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
6. Install piping free of sags and bends.
7. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.
8. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
9. Install piping to allow application of insulation plus 3-inch clearance around insulation.
10. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
11. Install fittings for changes in direction and branch connections.
12. Install couplings according to manufacturer's printed instructions.
13. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings in finished areas.
14. Verify final equipment locations for roughing in. Refer to equipment specifications in other Sections for roughing-in requirements.
15. Angle (wye) type strainers shall be provided with shutoff valve and cap on blowdown connection.
16. Where mains are reduced, provide eccentric reducing fittings installed with flat side on the bottom.
17. Horizontal piping shall not be installed less than 6 inches above finished floor (along walls), less than 7 ft-6 inches above finished floor (other areas), or in front of windows.
18. Piping shall be offset, relocated, or changed to clear ducts, beams, conduits and other obstacles.
19. Piping systems shall be free of noise and vibration under normal operating conditions.
20. Install piping to permit valve servicing.
21. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

- e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
- f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
- g. Bare Piping in Unfinished Service Spaces: No escutcheon.
- h. Bare Piping in Equipment Rooms: No escutcheon.
- i. Bare Piping at Floor Penetrations in Equipment Rooms: No escutcheon.

D. Sleeves

1. Install sleeves for pipes passing through concrete and masonry walls, fire-rated partitions, concrete floor and roof slabs, and where indicated.
 - a. Cut sleeves to length for mounting flush with both surfaces.
 - 1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.
 - b. Build sleeves into new walls and slabs as work progresses.
 - c. Install large enough sleeves to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - 1) Steel Pipe Sleeves: For pipes smaller than 6 inches.
 - 2) Steel Sheet-Metal Sleeves: For pipes 6 inches and larger that penetrate gypsum-board partitions.
 - 3) Cast Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - d. Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.
 - e. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants specified in Division 7 Section "Joint Sealants."
 - f. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.
 - 1) Install steel pipe for sleeves smaller than 6 inches.
 - 2) Install cast-iron wall pipes for sleeves 6 inches and larger.
 - 3) Assemble and install mechanical seals according to manufacturer's printed instructions.
 - g. Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron wall pipes for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.
 - h. Below Grade, Exterior Wall, Pipe Penetrations: Install ductile-iron wall penetration system sleeves according to manufacturer's printed installation instructions.
 - i. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping sealant material. Firestopping materials are specified in Division 7 Section Penetration Firestop.
2. Sleeves are not required for core-drilled holes.

E. Piping Joint Construction

1. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - a. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - b. ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendices.
 - c. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 - d. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
 - e. PVC Nonpressure Piping: Join according to ASTM D2855.
 - f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D3138 Appendix
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
11. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.
12. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
 - a. Plain-End Pipe and Fittings: Use butt fusion.
 - b. Plain-End Pipe and Socket Fittings: Use socket fusion.
13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

F. Piping Connections

1. Piping Connections: Except as otherwise indicated, make piping connections as specified below.
 - a. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a threaded pipe connection.
 - b. Install flanges in piping 2-1/2 inches and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
 - c. Dry Piping Systems (Gas, Compressed Air, and Vacuum): Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - d. Wet Piping Systems (Water and Steam): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

G. Equipment Installation – Common Requirements

1. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.
2. Install equipment according to submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Owner's Representative.
3. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.
4. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
5. Install equipment giving right-of-way to piping systems installed at a required slope.

H. Painting And Finishing

1. Refer to Division 9 for field painting requirements.
2. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

I. Fabrication and Erection of Metal Equipment Supports and Anchorage

1. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical equipment.
2. Field Welding: Comply with AWS D1.1 "Structural Welding Code – Steel."

J. Cutting and Patching

1. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for plumbing installations. Perform cutting by skilled mechanics of the trades involved.
2. Repair cut surfaces to match adjacent surfaces.

K. Grouting

1. Install non-metallic non-shrink grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.
2. Clean surfaces that will come into contact with grout.

3. Provide forms for placement of grout, as required.
 - a. Avoid air entrapment when placing grout.
 - b. Place grout to completely fill equipment bases.
4. Place grout on concrete bases to provide a smooth bearing surface for equipment.
5. Place grout around anchors.
6. Cure placed grout according to manufacturer's printed instructions.

3.4 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes hangers, supports, and restraints for Plumbing systems including piping and equipment as shown on the Contract Drawings.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
- B. Ohio Plumbing Code
- C. Manufacturers Standardization Society (MSS):
 - 1. MSS SP-58-2009 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation
 - 2. MSS SP-127-2001 - Bracing for Piping Systems - Seismic-Wind-Dynamic Design, Selection, Application

1.3 REQUIREMENTS

- A. Coordinate layout and installation of hangers, supports and restraints of plumbing piping systems with other mechanical systems including HVAC equipment and ductwork, electrical equipment, and light fixtures

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- C. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.
 - 1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent

1.5 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.
 - 2. Seismic Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is

experienced in providing seismic engineering services, including the design of seismic restraints, that are similar to those indicated for this Project.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All components shall be stainless steel construction for corrosion resistance.
- B. All components of like size and type shall be the product of the same manufacturer for purposes of parts interchangeability.

2.2 MISCELLANEOUS MATERIALS

- A. Structural steel:
 - 1. Stainless steel, Type 316, ASTM A276
- B. Grout: ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

2.3 UPPER HANGER ATTACHMENTS

- A. Standard-Duty Beam Clamps (for piping): Stainless steel jaw, stainless steel tie-rod, nuts, and washer. Underwriters Laboratories (UL) listed, Factory Mutual approved
- B. Heavy-Duty Beam Clamps (for large pipe and equipment): Stainless steel
- C. Welded Structural Attachments: Carbon steel. Coat after welding for corrosion control.
- D. Brace Fitting: Stainless bracket and pipe end, hex-head cap screw and nut
- E. Wall Brackets: Factory-fabricated stainless steel bracket with knee brace
- F. Concrete Inserts (for new upper deck construction only):
 - 1. Stainless steel inserts, threaded for rod.
 - 2. Stainless steel inserts with lateral adjustment capability
- G. Concrete Attachments: stainless steel plate with factory-drilled anchor holes and factory-welded rod attachments

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert wedge-type, stainless steel anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 METAL PIPE HANGERS AND SUPPORT

- A. Stainless-Steel Pipe Hangers and Supports
 - 1. Description: MSS SP-58, Types 1 through 58, factory fabricated components.
 - 2. Galvanized Metal Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic coatings: Plastic coating, jacket or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Stainless Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe Hangers:
 1. Description: MSS SP-58, Types 1 through 58, copper coated steel, factory-fabricated components.
 2. Hanger Rods: Continuous-thread rod, nuts and washer made of stainless steel.

PART 3 - EXECUTION

3.1 GENERAL

- A. Hangers, supports, clamps, fasteners, and hardware installed in process areas or outdoors shall be stainless steel. In general, process areas encompass all areas except Admin Building.
- B. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- C. Vertical Piping:
 1. Support vertical risers of piping systems by means of heavy duty hangers installed close to base of pipe risers, and by riser clamps with extension arms at intermediate floors, with the distance between clamps not to exceed 25feet, unless otherwise specified. Support pipe risers in vertical shafts equivalent to the aforementioned. Install riser clamps above floor slabs, with the extension arms resting on floor slabs or pipe sleeves. Provide adequate clearances for risers that are subject to appreciable expansion and contraction caused by operating temperature ranges.
 2. Support for extension arms of riser clamps which are secured to risers to be insulated for cold service shall be 4 inches above floor slabs, to allow room for insulation and vapor sealing around riser clamps.
- D. Use clevis hangers for horizontal runs less than 20 feet long.
- E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes.
- F. Insulated Piping: Comply with the following:
 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

- a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.

3.2 HANGER SCHEDULE

- A. Horizontal piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
- B. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
- C. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
- D. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. C-Clamps (MSS Type 23): For structural shapes.
 2. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
- E. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
- F. Comply with MSS SP-58 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- G. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.3 PIPE HANGER SPACING

- A. Space hangers or supports for horizontal piping on maximum center distances as indicated in Table 4 of MSS SP-58.
- B. CPVC pipe operating above 70 deg F shall have continuous support.
- C. For Directional Changes: Install a hanger or support close to the point of change of direction of all pipe runs in either a horizontal or vertical plane.
- D. For Concentrated Loads: Install additional hangers or supports, spaced as required and directed, at locations where concentrated loads such as in-line pumps, valves, fittings or accessories occur, to support the concentrated loads.
- E. For Branch Piping Runs and Runouts over 5 feet in Length: Install a minimum of one hanger, and additional hangers if required by the hanger spacing schedules.

- F. Parallel Piping Runs: Where several pipe lines run parallel in the same place and in close proximity to each other, trapeze hangers may be submitted for approval. Base hanger spacing for trapeze type hangers on the smallest size of pipe being supported. Design the entire hanger assembly based on a safety factor of five, for the ultimate strength of the material being used.
- G. Support floor drain traps from the overhead construction, with hangers of type and design as required. Over-head supports are not required for floor drain traps installed directly below earth supported concrete floors

3.4 ANCHORS, RESTRAINTS, RIGID SUPPORTS, STAYS AND SWAY BRACES

- A. Install pipe anchors, restraints and sway braces, at locations noted on the Drawings. Design anchors so as to permit piping to expand and contract freely in opposite directions, away from anchor points. Install anchors independent of all hangers and supports, and in a manner which will not affect the structural integrity of the building.
- B. In grooved-end piping systems, install restraints, anchors, and rigid supports as recommended by the manufacturer of the grooved end fittings to ensure proper support and alignment of the piping under operating and testing pressures (maximum hanger or support spacing shall be as previously specified).:
 - 1. Horizontal piping shall maintain a constant pitch without sags, humps, or lateral deflections.
 - 2. Branch piping shall remain perpendicular to main piping and/or risers.
 - 3. Vertical piping shall remain plumb without deflections.
 - 4. Vertical piping shall be rigidly supported, or anchored at both top and bottom and wherever necessary to prevent movement and/or shearing forces at branch connections

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 EQUIPMENT HANGERS

- A. Provide vibration isolating hangers for equipment with motors.
- B. Support air terminal units independent of ductwork.
- C. Support slot diffusers independent of suspended ceiling grid.

3.7 RODS

- A. Pipe and duct hanger rods shall be full size to match hangers.
- B. Trapeze and equipment hanger rods shall be sized for maximum load with a safety factor of five.
- C. Provide two nuts at each end of rods for positioning rod and hanger and locking each in place.

3.8 UPPER HANGER ATTACHMENTS

- A. General

1. Upper hanger attachments shall be made to structural steel wherever possible.
2. Powder-driven drive pins shall not be used.
3. Expansion nails shall not be used.
4. Powder-driven fasteners shall not be used in precast concrete.
5. Loads in excess of 250 pounds shall not be supported from a single welded or powder-driven stud.

B. Stainless Steel or Aluminum Frame Construction

1. Provide intermediate structural members where required by ductwork support spacing. Select members based on a minimum safety factor of five.
2. Secure upper hanger attachments to steel bar joists within 6 inches of panel points, or provide intermediate strut to transfer load to top chord of joist.
3. Holes shall not be drilled in structural steel members.
4. Friction clamps shall not be used.

3.9 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.10 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Identification for Plumbing Piping and Equipment as shown on the Contract Drawings.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. American National Standards Institute (ANSI)
 - a. ANSI A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data. For each product specified submit manufacturer's catalog sheets and specifications showing its compliance with this specification and the referenced standards.

1.4 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.
- B. Identifying labels and markings for piping shall conform to ANSI A13.1 for legend, color, visibility, and size of legend and letters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 - 1. Seton Identification Company, Branford, Connecticut.
 - 2. W. H. Brady Corporation, Milwaukee, Wisconsin.
 - 3. Or equal.

2.2 MATERIALS AND CONSTRUCTION

- A. Pipe Identification Painting
 - 1. Type: As identified in Section entitled "Field Painting."
 - 2. Color: As scheduled in Paragraph 3.2.
- B. Pipe Identification Markers:
 - 1. Snap-On Type: Precoiled acrylic plastic marker with clear polyester coating, incorporating flow arrows, and legend printed in alternate directions.
 - a. Piping or insulation under 6 inch O.D.: One piece wrap around type with 3/4 inch adhesive strip on inside edge and 360 degree visibility.
 - b. Piping or insulation 6 inch O.D. and larger: Strip type with factory applied grommets, secure with stainless steel spring fasteners.
 - 2. Stick-On Type: One piece pressure sensitive adhesive backed plastic marker with clear polyester coating, incorporating flow arrows, and legend printed in alternate directions.
 - a. Piping or insulation under 8 inch O.D.: Wrap around type with 360 degree visibility.
 - b. Piping or insulation 8 inch O.D. and larger: Strip type.
 - 3. Markers shall be color coded based on pipe contents. Color selection shall be according to chart in Part 3 of this Section.
- C. Pipe Banding Tape:
 - 1. 1-1/2 inch width (minimum), pressure sensitive adhesive backed type, of same material as pipe identification mark, and of color to match background color of pipe identification marker.
- D. Pipe Service Identification Tags:
 - 1. Type: Brass, 19 B&S gage, with 1/4 inch high pipe service abbreviated lettering over 1/2-inch high pipe size lettering. Lettering shall be deep stamped and black filled. Tag to have 3/16 inch diameter hole at top for fastening.
 - 2. Size: 2 inch square tag.
 - 3. Fasteners: Brass "S" hook or brass jack chain, size as required for pipe to which tag is attached.
- E. Valve Identification Tags:
 - 1. Type: Brass, 19 B&S gage, with 1/4 inch high valve service abbreviated lettering over 1/2-inch high lettering indicating valve service chart number. Lettering shall be deep stamped and black filled. Tag to have 3/16 inch diameter hole at top for fastening.
 - 2. Size:
 - a. Plumbing: 1-1/2 inch hexagon tag.
 - 3. Fasteners: Brass "S" hook or brass jack chain, size as required for valve stem or handle to which tag is attached.
- F. Equipment Identification Letters & Numbers:
 - 1. Type: Stick-on type, made of all purpose polyester, single character letters and numbers, specifically designed for outdoor use.

2. Color: Black letters on bright yellow background.
3. Size: Letters and numbers shall be 1 inch or 3 inches in height, as specified.

2.3 ACCESSORIES

A. Valve Service Identification Chart Frames:

1. Satin finished extruded aluminum frame of size to fit 8-1/2 x 11 inch valve chart and complete with rigid clear plastic glazing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 IDENTIFICATION

A. Piping General:

1. Bare piping shall be painted in accordance with Section entitled "Painting". Paint colors shall be coordinated with piping contents and existing plant piping colors. Painting shall include color coding and identification by stenciled lettering.
2. Small piping and insulated piping shall be identified as to content and direction of flow by use of pipe identification markers or tags.
3. Identify all piping, bare or insulated, whose contents match those listed in the Pipe Identification Schedule, with the following exceptions:
 - a. Piping in furred spaces or above plastered ceilings, except at access panels where valves and piping shall be identified as specified for exposed piping.
 - b. Piping in finished spaces such as offices, toilet rooms, locker rooms, etc.
4. Marker legend size, field color, and length of field shall be in accordance with ANSI A13.1.
5. Legend wording shall be developed by the Contractor and submitted for review (see Section 1.3,B). Whenever possible, standard terminology should be used. Identification by the combination of two or more standard labels (at each identification point) is acceptable.

B. Use of Markers or Tags:

1. Pipe or insulation with an outside diameter (O.D.) of 3/4 inch and less shall be identified by the use of Pipe Service Identification Tags.
2. Pipe or insulation with an O.D. larger than 3/4 inch shall be identified by the use of Pipe Identification Markers.
3. Either snap-on or stick-on type markers may be used; except that stick-on markers shall not be used in the following situations:
 - a. Areas where humid, wet, or dripping conditions are anticipated.
 - b. Areas where chemical fumes are anticipated.
 - c. Outdoor installations.
 - d. On lines subject to 50 degree F temperature variations.

C. Location of Markers and Tags:

1. Pipe markers and tags shall be located so as to be readily visible from any reasonable point of observation.
2. Locate identification at all valves, branch or riser take-offs, and both sides of pipe passage through walls, floors, and ceilings.
3. On continuous pipe runs locate identification at 20 foot intervals, but not less than one marker or tag on any length of 10 feet or greater.

D. Preparation:

1. Insure that any painting is complete and the paint has thoroughly dried before applying identification.
2. Prepare surface in accordance with the manufacturer's instructions for the type of identification used and the surface to which it is applied.

E. Installation:

1. Install markers and tags in accordance with the manufacturer's instructions.
2. Secure both ends of stick-on type markers with 360 degree application of pipe banding tape. Tape shall have one inch lap on pipe or insulation.

F. Pipe Identification Schedule: Identify the following types of piping with markers and/or tags.

Pipe Service	Pipe Label	Valve Tag Abbreviation	Background Color	Letter Color
Potable Water Supply	Potable Water	POT	Green	White
Tepid Water for Eyewash and Safety Shower	Eyewash Shower	EWS	Green	White
Plant Water	Plant Water	PW	Green	White
Plant Effluent	Plant Effluent	PE	Green	White
Seal Water	Seal Water	SW	Green	White
High-Pressure Wash Water	Wash Water	WW	Green	White
Sanitary Drainage	Sanitary Drain	SAN	Green	White
Sanitary Vent	Sanitary Vent	SAN-V	Blue	White

G. Installation:

1. Fasten tags to valve stems or handles using brass "S" hooks or jack chain.
2. Fasten tags in a manner and location that will permit easy reading, but will not interfere with the operation of the valve.

H. Valve Service Identification Chart:

1. Provide two framed valve charts for each piping system to have valve identification tags.
2. Charts shall be typed, in the reviewed format, on 8-1/2 x 11 inch heavy white bond paper and framed in an aluminum frame. Hang framed charts at location(s) directed.

I. Equipment Identification General:

1. Identify plumbing equipment, bare or insulated, in the following locations, by use of stick-on letters and numbers:
 - a. Mechanical Equipment Rooms.
 - b. Boiler rooms.
 - c. Penthouses.
 - d. Suspended ceiling plenums.
 - e. Roof mounted equipment.

J. Location and Content of Identification:

1. Equipment shall be identified with a minimum of two sets of lettering. Center identification lettering, vertically and horizontally, on opposite vertical sides of the equipment.
2. Vertical sides selected shall have the longest dimension (i.e., label sides of equipment and not the ends), unless view is obstructed to those sides. If view is obstructed to sides of equipment, locate identification lettering on the two most visible vertical sides and/or ends.
3. Equipment identification numbers and letters shall match the designation found in the equipment schedules on the Contract Drawings.

K. Size of Lettering:

1. Use the largest lettering size (3 inch or 1 inch height) that will easily fit the available surface space.
2. Use only one lettering height on any given piece of equipment (i.e., do not mix lettering sizes).

L. Installation:

1. Prepare surface to which lettering is applied and install lettering in accordance with the manufacturer's instructions.
2. Apply lettering in a straight line along the axis of the equipment. Lettering edges should touch, but not over-lap.

END OF SECTION

SECTION 22 05 93

PIPE PRESSURE TESTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe pressure tests for plumbing piping systems as scheduled in Part 3 of this section.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. 2009 International Plumbing Code

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. In addition to those submittals identified in the General Conditions, the following items shall also be submitted:
- C. Test Reports
 - 1. A separate test report shall be submitted for each pressure test performed.
 - 2. Information presented in test reports shall be typewritten, clear, concise, and accurate.
 - 3. Reports shall be signed and dated by the supervisor in charge of performing the test and designated Inspector. Signatures shall certify that all information contained in the report is true and accurate to the best of the signatory's knowledge.
 - 4. Reports shall contain, as a minimum, the following information:
 - a. Type of test performed (e.g., hydrostatic, pneumatic, refrigerant, etc.)
 - b. Description of system or portion of system to which testing was performed.
 - c. Date of test.
 - d. Time of pressure start.
 - e. Time of pressure test completion.
 - f. Test fluid used in test (e.g., tap water, dry air, refrigerant, etc).
 - g. Pressure reading at beginning of test.
 - h. Pressure reading at end of test.
 - i. Location of pressure indicating devices.
 - j. Precise location of leaks detected.
 - k. Summary of leaks detected and suggested corrective action.
 - l. Conclusions regarding overall fitness and condition of tested system.
 - m. Signatures as described above.
 - n. Appendix: Calibration history of instruments used.
- D. Close-Out Submittals: provide a copy of each final test report to the Owner.

1.4 QUALITY ASSURANCE

A. Tester's Qualifications

1. Workers and their supervisors performing the Work of this section shall be personally experienced in testing of pipe systems and shall have been regularly employed by a company with three years minimum experience in testing of similar pipe systems.

B. Inspection

1. Tests shall be performed by the Contractor in the presence of designated Inspector(s). Witness and signoff is required.
2. Inspectors shall, at all times, have access to any place where work is in preparation or in progress and Contractor shall provide sufficient safe and proper facilities for such access and inspection.

C. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.5 SCHEDULING AND SEQUENCING

- A. Perform test operations on complete piping system or in sections as required and/or directed to progress Work in satisfactory manner and not delay the general construction of the project.
- B. If testing is performed in sections, valve or cap-off sections of piping to be tested, utilizing valves to be installed in permanent piping systems or temporary valves or caps as required to perform tests.
- C. Transmit written notification of proposed date and time of pressure tests to the Owner's Representative at least 5 days in advance of such tests.
- D. Pressure tests shall be performed prior to the installation of piping insulation or coverings.
- E. Pressure tests on underground piping shall be performed when piping has been partially backfilled with joints exposed.
- F. Pressure tests shall be performed prior to initial operation of piping systems.

PART 2 - PRODUCTS

2.1 TEST MATERIALS

- A. Test Fluid: Where scheduled, test media shall meet the following criteria.
 1. Tap Water: Untreated well water or plant water.
 2. Drinking Water: Treated, chlorinated potable water.

2.2 TEST EQUIPMENT

- A. Gauges: Calibrated, dial-type, suitable for use with specified test fluid. Upper limit of gauge pressure range shall be 1.33 times the specified test pressure. Gauge accuracy shall be 1 percent of the indicated reading or better.
- B. Soap Solution: American Gas & Chemical, "Leak-Tec"; or equivalent.
- C. Air Compressor: Unit rated to supply compressed air at or above required test pressure. Unit shall have necessary filters and driers to deliver clean, oil-free, dry compressed air. Unit shall have shut-off valve installed on discharge connection.
- D. Pressure Relief Valve: Suitable for use with compressed air, set to relieve at 10 to 15 percent above designated test pressure.

PART 3 - EXECUTION

3.1 GENERAL

- A. Tests shall be conducted at ambient temperature, unless otherwise specified.
- B. Do not use permanent system pressure gauges for pressure testing; remove and plug or isolate such gauges from the system during pressure tests.
- C. Instrumentation in, or attached to, the piping being tested shall be protected during testing by isolation or removal. Return instrumentation to pre-test condition after completion of pressure testing.
- D. Piping connected to specialties or equipment with a lower pressure rating than the specified test pressure shall be disconnected from the equipment (after the isolation valve) and openings plugged during the pressure test. After the completion of pressure testing, the piping shall be reconnected to the equipment.
- E. Expansion joints shall be provided with temporary restraint or blocked off during testing.
- F. Pressurization of piping systems by liquids or gases shall be executed in a slow and prudent manner to maintain safety, avoid over-pressurization, and avoid excessive leakage.
- G. If the piping fails the test requirements, the Contractor shall determine the cause of leakage, make necessary repairs, and retest the piping. This procedure shall be repeated until the piping complies with test requirements. A separate test report shall be submitted for each test to a piping system or section of piping.
- H. No caulking or putty shall be used in the repair of leaks. Back welding of threaded joints shall not be permitted as a means of repairing leaks.
- I. Test reports shall be filled out and readings recorded as testing proceeds.

- J. Safety glasses and hard hats shall be worn by personnel involved in or witnessing tests conducted at pressure of 20 psig or greater.

3.2 EXAMINATION

- A. Examine equipment and construction in the area of piping to be tested. Note equipment and existing construction that may be damaged by leakage of the test fluid.
- B. Verify that piping system bracing, alignment harnesses, and thrust restraints are in place before pressure is applied. Concrete restraints shall have cured adequately to withstand test pressure.
- C. Proceed with testing only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

- A. Protect equipment and construction which may be damaged by leakage of test fluid by covering with appropriate material or removing from area.
- B. Verify that piping to be tested is clean and all outlets in the system are closed.
- C. Open non-outlet valves in piping section to be tested. Check valves that can prevent system sections from being filled or pressurized shall have their discs, etc. removed for testing (restore check valves to their pre-test condition after completion of pressure testing).
- D. Evacuate test areas of personnel not involved in the pressure testing.

3.4 HYDROSTATIC PRESSURE TEST

- A. Install pressure gauge to measure system pressure at low point in system.
- B. Connect pressurization pump to system.
- C. Fill the system with test liquid, opening vents to permit complete filling. Close vents.
- D. Using the pump, raise the pressure in the system to the scheduled test pressure. Hold pressure for a minimum of 1 hour.
- E. Reduce and hold the pressure 20 percent below test pressure. Inspect the entire system for visible leaks. Note location of leaks for repair.
- F. If leaks or defects are found, release the pressure, drain the system, and make repairs. Repeat the test procedure on the repaired piping.
- G. If the piping shows no visible leakage, raise the pressure in the system to the scheduled test pressure and isolate the system, under pressure, from the pump. The system should be closed with the pressure gauge indicating test pressure within system.

- H. System shall remain pressurized for the duration indicated in the test schedule. After the specified duration, check pressure reading on system gauge. No detectable drop in pressure shall have occurred in the system.
- I. If a drop in pressure occurs, Contractor shall determine cause. Once cause is determined release the pressure, drain the system, repair pipe as necessary, and retest.
- J. Upon compliance with test requirements, drain the system, remove items added or replace those removed for testing.

3.5 PIPE TEST SCHEDULE

- A. Perform pressure tests, of type indicated, on piping system(s) indicated using scheduled test fluid and pressure.
- B. Schedule

UTILITY	TEST METHOD	TEST MEDIUM	TEST PRESSURE	TEST DURATION	LEAKAGE
Potable Cold and Hot Water & Tempered Water	Hydrostatic	Water	100 psig	1 Hour	0
Non-Potable Water	Hydrostatic	Water	100 psig	1 Hour	0
Wash Water	Hydrostatic	Water	4500 psig 3000 psig	10 minutes 1 hour	
Sanitary DWV	Gravity	Water	10 ft. of water	3 hours	0

END OF SECTION

SECTION 22 07 19

PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulation for plumbing work.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. 2009 International Plumbing Code
 - 2. American Society for Testing and Materials (ASTM)
 - 3. Military Specifications (MIL), as applicably noted.
 - 4. International Energy Conservation Code.

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- C. Shop Drawings:
 - 1. Pipe
 - a. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
 - b. Attachment and covering of heat trace inside insulation.
 - c. Insulation application at pipe expansion joints for each type of insulation.
 - d. Removable insulation at piping specialties and equipment connections.
 - e. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - f. Application of field-applied jackets.

1.4 QUALITY ASSURANCE

- A. Qualifications
 - 1. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - a. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 - b. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
- B. Maintain ambient conditions required by manufacturers of tapes, adhesives, mastics, cements, and insulation materials.

PART 2 - PRODUCTS

2.1 MINERAL FIBER INSULATION

- A. Manufacturers:
 - 1. CertainTeed Saint-Gobain.
 - 2. Johns Manville
 - 3. Knauf Insulation
 - 4. Owens Corning
 - 5. Or approved equal.
- B. Description:
 - 1. Fibrous Glass (Mineral-fiber) Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 - a. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket with or without self-sealing lap as applicable for application.
 - b. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - 1) Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - 2) Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 - c. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 - d. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 - e. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
 - f. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.2 FLEXIBLE ELASTOMERIC INSULATION

- A. Manufacturers:
 - 1. Armacell
 - 2. Aeroflex USA Inc., Aerocel.
 - 3. Rubatex International
 - 4. Or equal.
- B. Description:

1. Flexible Elastomeric: Closed cell, sponge or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials
 - a. Flexible Elastomeric Adhesive: Comply with MIL-A-24179a, Type II, Class I.

2.3 FIELD-APPLIED JACKETS

A. Manufacturers:

1. Johns Manville; Zeston.
2. P.I.C. Plastics, Inc.; FG Series.
3. Proto Corporation; LoSmoke.
4. Speedline Corporation; SmokeSafe.
5. Or equal.

B. PVC Jacket

1. PVC jacket for straight pipe, manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC for indoor use only
2. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC for indoor use only. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, traps, grooved pipe joints, grooved pipe fittings
3. Jacket installed outdoors shall be suitable for installation in sunlight.
4. PVC Jacket Color: White.
5. Adhesive: As recommended by insulation and/or material manufacturer for temperature application.

C. Description:

1. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
2. Heavy PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 30-mil-thick, high-impact, ultraviolet-resistant PVC. Application; as noted for mechanical rooms and outdoor use.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 - b. Adhesive: As recommended by insulation and/or material manufacturer for temperature application.
3. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC for indoor use only.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 - b. Adhesive: As recommended by insulation and/or material manufacturer for temperature application.

2.4 ACCESSORIES

A. Description:

1. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz/yd².
 - a. Tape Width: 4 inches.
2. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
 - a. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
 - b. Aluminum: 0.007 inch thick.
3. Wire: 0.062-inch, soft-annealed stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 INSTALLATION GENERAL

- A. All insulation shall have PVC jacket.
- B. Install materials as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- C. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of equipment, fittings and piping, including fittings, valves and specialties.
- D. Refer to schedules at the end of this Section for materials, jackets, and thicknesses required for each piping system.
- E. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- F. Apply multiple layers of insulation with longitudinal and end seams staggered.
- G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during storage, application and finishing.
- I. Apply pipe insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- L. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- M. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- N. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- O. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
 - 3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.
 - 4. Circumferential Joints: Cover with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 - 5. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
- P. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- Q. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.

2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 3. Seal insulation to roof flashing with vapor-retarder mastic.
 4. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- S. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.
- T. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.
1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
 3. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
 4. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
- C. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover indoor fittings with standard PVC fitting covers.
 4. Cover mechanical room and outdoor fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure

fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

- D. Apply insulation to valves and specialties as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Indoors: Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 5. Outdoors: Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Follow manufacturer's written instructions for applying insulation.
 2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- B. Apply insulation to flanges as follows:
1. Apply pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- C. Apply insulation to fittings and elbows as follows:
1. Apply mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- D. Apply insulation to valves and specialties as follows:
1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
 2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without

disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.

3. Apply insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.6 INSTALLATION OF FIELD-APPLIED JACKET

- A. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
- B. Apply metal jacket where indicated, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FIELD QUALITY CONTROL

- A. Inspection: Engage a qualified inspection agency to perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:
- B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.
- C. Reinstall insulation and covers on piping uncovered for inspection according to these Specifications.

3.8 IDENTIFICATION

- A. Identify piping and valves as specified in Identification for Plumbing Piping and Equipment Section.

3.9 SCHEDULE

- A. Refer to insulation application Table 1 for required insulation thicknesses.

PART 4 - TABLE 1 – PIPE INSULATION THICKNESS

Pipe Service	Insulation Thickness	
	MF	FE
Cold Potable Water – All sizes	½"	½"
Plant Water	½"	½"
Hot Potable Water – up to & including 1 ½" dia.	1"	1"
Hot Potable Water – 2" dia. & larger	1 ½"	1 ½"

Tepid Water for Emergency Eyewash and Shower	½"	½"
Wash Water	1"	1"
Condensate Drain Piping	NA	½"
Rainwater Conductors	NA	1"
Roof Drain Bodies	NA	1"

END OF SECTION

SECTION 22 10 00

PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes Domestic Water Piping including all potable water piping systems as shown on the Contract Drawings.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. 2009 International Plumbing Code.
 - 2. American Society of Mechanical Engineers (ASME)
 - a. ASME B16.3 – Malleable Iron Threaded Fittings Class 150 NS 300.
 - 3. American Water Works Association (AWWA)
 - a. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3" through 48" for Water.
 - b. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile Iron or Gray-Iron Threaded Flanges
 - c. AWWA C151 - Standard for Ductile-Iron Pipe, Centrifugally Cast.
 - 4. American Society for Testing and Materials (ASTM)
 - a. ASTM F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - 5. American Society For Testing and Materials (ASTM)
 - a. ASTM A53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
 - b. ASTM D2846 – Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic and Cold Water Distribution Systems.
 - c. ASTM F438 – Specification for Socket-type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
 - d. ASTM F493 – Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
 - e. ASTM D2855 – Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
 - f. ASTM D1785 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 - g. ASTM D2466 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - 6. National Sanitation Foundation
 - a. NSF 61 -- Drinking Water System Components: Health Effects.

1.4 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of plumbing piping system with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
 - 1. Vertical and horizontal runs, offsets, and transitions.
 - 2. Clearances for access above and to the side.
 - 3. Show dimensions and details, including connections.
 - 4. Support locations, type of support, and weight on each support.
 - 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.5 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1.6 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Coordinate delivery of domestic water piping and fittings to allow movement into designated space.

1.8 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 SANITARY DRAINAGE PIPING, BELOW GRADE

- A. Under Building
 - 1. Cast Iron Soil Pipe: ASTM A74 service weight. Fittings: Cast iron. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets.
- B. Exterior of Building

1. Cast Iron Soil Pipe: ASTM A74 service weight. Fittings: Cast iron. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets.
2. Polyvinyl Chloride (PVC) SDR35 ASTM D2665. Fittings: Push on joint, PVC SDR35 rubber gasket, ASTM F477.

2.2 SANITARY VENT PIPING, BELOW GRADE

- A. Cast Iron Soil Pipe: ASTM A74 service weight. Fittings: Cast iron. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets.

2.3 SANITARY DRAINAGE PIPING, ABOVE GRADE

- A. Cast Iron Soil Pipe: CISPI 301, hubless, service weight. Fittings: Cast iron. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.4 SANITARY VENT PIPING, ABOVE GRADE

- A. Cast Iron Soil Pipe: CISPI 301, hubless, service weight. Fittings: Cast iron. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.5 STORM WATER DRAINAGE PIPING, BELOW GRADE

- A. Under Building
 1. Cast Iron Soil Pipe: ASTM A74 service weight. Fittings: Cast iron. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets.
 2. Polyvinyl Chloride (PVC) SDR35 ASTM D2665. Fittings: Push on joint, PVC SDR35 rubber gasket, ASTM F477.
- B. Exterior of Building
 1. Smooth Interior Corrugated Polyethylene Pipe (SICPP).

2.6 STORMWATER DRAINAGE PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight. Fittings: Cast iron. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.7 WATER PIPING, BELOW GRADE

- A. 3" diameter and below: Copper Tubing: ASTM B88, Type K. Fittings: ANSI/ASME B16.22, wrought copper. Joints: ANSI/ASTM B32, solder, Grade 95TA
- B. Water and fire protection piping, below grade: Ductile iron pipe, ANSI/AWWA C151 with cement lining ANSI/AWWA C104. Fittings: Ductile iron ANSI/AWWA C110. Joints: Restrained.

2.8 POTABLE COLD WATER PIPING, ABOVE GRADE

- A. 1/2" to 6" Pipe: Carbon Steel, ASTM A53, Black, Type E, schedule 40, Grade A. Fittings: 150# malleable iron, threaded, flanged.

2.9 TEPID WATER PIPING (FOR EMERGENCY EYEWASH/SHOWER)

- A. 1/2" to 6" Pipe: Stainless Steel, ASTM A312, Type 316, schedule 40. Fittings: 150# Type 316 stainless steel, threaded.

2.10 PLANT WATER PIPING (INCLUDING PLANT EFFLUENT WATER AND NON-POTABLE WATER)

- A. Pipe: Carbon Steel, ASTM A53, Black, Type E, schedule 40, Grade A. Fittings: 150# malleable iron, threaded, flanged, or grooved mechanical joint.
- B. Grooved Mechanical-Joint Couplings: Ductile-or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings
- C. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47 (ASTM A 47M), Grade 32510 malleable iron; ASTM A53, Type F, E, or S, grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings

2.11 SEAL WATER PIPING

- A. 1/2" to 2" Pipe: PVC, Schedule 80. Joints: solvent weld. Fittings: PVC, solvent welded ends. For RAS pumps seal water.
- B. 1/2" to 2" Pipe: Stainless Steel, Schedule 40. Joints: threaded. Fittings: stainless steel, threaded ends. For PEPS pumps seal water.

2.12 WASH WATER (HIGH-PRESSURE WATER PIPING)

- A. 1/2" to 2" Pipe: Schedule 80S stainless steel. Fittings: stainless steel, 6000 lb, socket weld. Joints: threaded or socket weld. System pressure: 3000 psi, maximum
- B. 1/2" to 2" Shutoff Valve: Ball valve, three-piece, stainless steel body, 6000 lb, threaded, teflon seats and seals, plastic-covered steel handle.

2.13 SHUTOFF VALVES

- A. 1/2" to 2" - Ball valve, stainless steel body, threaded, teflon seats and seals, plastic-covered steel handle, 150 psi.
- B. Over 3" to 10" - Gate valve, iron body, bronze mounted, flanged, non-rising stem, solid wedge, class 125.
- C. 2 1/2" to 10" – Butterfly valve, iron body, lug type, aluminum bronze disc, stainless steel trim, EPDM seat and seals, 150 psi, lever actuator. Keystone AR2 or approved equal.

2.14 CHECK VALVES

- A. 3/4" to 3" - Swing check, bronze body, solder or threaded, bronze disc, 150 lb.

2.15 FLEXIBLE CONNECTORS

- A. 3/4" to 4" - Stainless steel with stainless steel overbraid, threaded, 150 psi.

2.16 MANUAL AIR VENTS

- A. 1/4" brass tee head petcock.

2.17 LOW-POINT DRAIN VALVES

- A. 3/4" hose bibb.

2.18 GENERAL

- A. All components of like size and type shall be the product of the same manufacturer for purposes of parts interchangeability.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION

- A. Install piping and accessories in accordance with the configuration shown on Contract Drawings.
- B. All areas shall be interpreted as industrial and all piping shall be installed exposed unless otherwise shown or specified.
- C. Areas with a finished ceiling indicated on the Contract Drawings "Room Finish Schedule" shall have all piping concealed unless otherwise shown or specified.
- D. Sleeves shall be provided where piping passes through floors and walls.
 - 1. Sleeves shall be caulked watertight or gastight as required.
 - 2. Where water tightness or gas tightness is not required and the pipe is insulated, the sleeve shall be sized to permit full insulation thickness of pipe to be installed through the sleeve.
- E. Leakage tests shall be as specified.
- F. No fixture or equipment shall be connected directly to the potable water system in such a manner that a cross-connection exists and backflow of contaminated water into the potable water system could occur.
- G. All piping, except where noted, shall be kept as high as possible.

- H. All connections between ferrous and non-ferrous piping and equipment shall be made with dielectric unions.
- I. Copper piping installed in concrete shall be coated with bitumastic paint.
- J. All water piping shall be run true and plumb, free of traps, and installed with adequate clearance from mechanical work.
- K. All water piping shall pitch to drain at a slope of $\frac{1}{4}$ inch per 10 feet unless otherwise noted. Manual air vents shall be installed at all high points and drain valves shall be installed at all low points.
- L. Piping shall not be installed across or in front of doors or windows.
- M. All piping shall be routed parallel to building column lines.
- N. All hot and cold water lines above grade shall be insulated. All exposed insulated piping within five (5) feet of finished floor shall have a metal jacket.
- O. All potable and tepid (eyewash and safety shower) water piping shall be disinfected in accordance with the Ohio Plumbing Code, Section 610.
- P. Install water hammer arresters complete with accessible isolation valve.
- Q. Install lowpoint drain valves with threaded nipple and cap.

3.3 VALVE INSTALLATION

- A. Install plumbing valves as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install check valves for proper direction of flow.

3.4 IDENTIFICATION

- A. Plain and insulated piping shall be painted. Refer to section entitled "Painting".
- B. Identify piping as specified in accordance with the Section entitled "Identification for Plumbing Piping and Equipment."

3.5 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 22 11 19

PLUMBING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Plumbing Specialties including backflow preventers, water hammer arresters, hose bibbs, hose valves, wall hydrants, trap primer valves and distribution units as shown on the Contract Drawings.

1.2 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society of Sanitary Engineering (ASSE)
 - a. ASSE 1011 - Hose Connection Vacuum Breakers
 - b. ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
 - 2. American National Standards Institute (ANSI)
 - a. ANSI A112.21.1 - Floor Drains.
 - b. ANSI A112.2.1.2 - Roof Drains.
 - c. ANSI A112.26.1 - Water Hammer Arresters.
 - 3. American Society for Testing and Materials (ASTM)
 - a. ASTM A 48 – Specifications for Gray Iron Castings.
 - b. ASTM A126 – Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 4. National Sanitation Foundation (NSF)
 - a. NSF 61 – Drinking Water System Components – Health Effects.
 - 5. American Society of Mechanical Engineers (ASME)
 - a. ASME B120.1 – Pipe Threads, General Purpose (inch).
 - 6. Plumbing and Drainage Institute (PDI)
 - 7. 2009 International Plumbing Code

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of Domestic Water Piping Specialties with electrical equipment, light fixtures, HVAC equipment and ductwork, and piping.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: “Catalog cuts” and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
 - 1. In addition to those submittals identified in the General Conditions, the following items shall also be submitted.

2. Submit minimum inlet pressure requirements and pressure drop data for backflow preventers.

1.5 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.6 WARRANTY

- ### A. Provide parts and labor warranty in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Manufacturers / Models - 3/4" through 2" diameter :

1. Zurn – Wilkins Model 975XL
2. Watts Regulator Company - Model 909.
3. Febco Sales Inc - Model 825Y.
4. Or approved equal.

B. Manufacturers / Models - 2-1/2" through 10" diameter :

1. Zurn- Wilkins Model 375
2. Watts Regulator Company - Model 909.
3. Febco Sales Inc - Model 860.
4. Or approved equal.

C. Description:

1. Reduced pressure zone backflow preventers shall have a relief valve located between two independently operating check valves. Backflow preventers shall be designed for horizontal flow installation and sized as indicated on Contract Drawings.

2.2 WATER HAMMER ARRESTER

A. Manufacturers / Model:

1. Precision Plumbing Products, Inc. - Model SC
2. Watts - SG Series
3. Zurn Industries, Inc - Wilkins Model 1250.
4. Or approved equal.

B. Description:

1. Water hammer arrester shall have copper body construction suitable for operating pressures up to 150 psig.

2.3 HOSE BIBB

A. Manufacturers:

1. Chicago Faucet Company.
2. NIBCO.
3. Acorn.
4. Or approved equal.

B. Description:

1. Hose bibbs shall have a 3/4-inch flanged female I.P.S. Inlet, 3/4-inch hose thread outlet with lock shield cap, vacuum breaker, and polished chrome plate finish.

2.4 NON-FREEZE WALL HYDRANT

A. Manufacturers:

1. Josam Manufacturing Company.
2. J.R. Smith Manufacturing Company.
3. Zurn Industries, Inc.
4. Or approved equal.

B. Description:

1. Wall Hydrant shall be of the non-freeze type with a bronze box and chrome plated face, bronze hydrant, bronze casing, hose connection, integral vacuum breaker, 3/4-inch inlet connection and a "T" handle key.

2.5 TRAP PRIMER VALVE

A. Manufacturers:

1. Precision Plumbing Products, Inc.
2. J.R. Smith Manufacturing Company.
3. Or approved equal.

B. Description:

1. Trap Primer Valve shall be provided to supply water to floor drain trap to prevent loss of trap seal.

2.6 TRAP PRIMER DISTRIBUTION UNIT

A. Manufacturers:

1. Precision Plumbing Products, Inc.
2. Or approved equal.

B. Description:

1. Distribution unit shall have a copper reservoir with brass fittings and clear plastic inspection cover on side of reservoir. Unit shall be provided with mounting brackets.

2.7 ROOF DRAINS (R.D.)

A. Manufacturers:

1. J.R. Smith Manufacturing Company.
2. Zurn Industries, Inc.
3. Josam Manufacturing Company.
4. Or approved equal.

B. Description: Roof drain shall have a cast iron body with flashing clamp, gravel stop, polyethylene dome, under-deck clamp, sump receiver, and a bottom outlet connection.

2.8 FLOOR DRAINS (F.D.)

A. Manufacturers:

1. J.R. Smith Manufacturing Company.
2. Zurn Industries, Inc.
3. Josam Manufacturing Company.
4. Or approved equal.

B. Description:

1. Type "A" floor drain to be used in finished areas. The drain shall have a cast iron body with a flashing collar, an adjustable nickel bronze strainer head with a 6-inch diameter round top a 1/2-inch trap primer connection and a bottom outlet connection.
2. Type "B" floor drain to be used for indirect waste. The drain shall have a cast iron body and flashing collar, seepage openings, 8-inch diameter nickel-bronze adjustable strainer head with 4-inch nickel-bronze funnel attached, 1/2-inch trap primer connection, and a bottom outlet connection.
3. Type "C" floor drain to be used in unfinished areas. The drain shall have a cast iron body and flashing collar, 12" diameter adjustable top and bar grate with sediment bucket, and a bottom outlet connection.
4. Type "D" floor drain to be used in unfinished areas. The drain shall have a cast iron body and flashing collar, 15"diameter adjustable top and bar grate with sediment bucket, and a bottom outlet connection.

2.9 DECKPLATE CLEANOUT (D.P.C.O.)

A. Manufacturers:

1. J.R. Smith Manufacturing Company.
2. Zurn Industries, Inc.
3. Manufacturing Company.
4. Or approved equal.

B. Description:

1. Cleanout for finished floor areas shall have a cast iron body with round nickel-bronze adjustable top.
2. Cleanout for unfinished floor areas shall have a cast iron body with round extra heavy duty cast iron adjustable top.

2.10 TRENCH DRAIN

- A. Trench drain shall be factory fabricated system that assembles in the field.
- B. Trench drain system shall include fiber-reinforced concrete channel with 12" wide throat opening, ductile iron edge rails and ductile iron grated cover. Assembly shall be suitable for municipal waste water treatment plant application. Installed assembly shall be rated for Class E loading.
- C. Provide pitched or stepped channel to promote fluid flow to sump. Channel shall have bottom outlet at low end.
- D. Provide closed end caps. End caps shall be constructed from iron.
- E. Trench drain shall be Sigma Hydrotec Maxi 300 or approved equal.

2.11 GENERAL

- A. All components of like size and type shall be the product of the same manufacturer for purposes of parts interchangeability.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install Plumbing Piping Specialties as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Provide trap primers for all floor drains, unless otherwise noted.
- C. Pipe relief from backflow preventer to nearest drain.
- D. Install water hammer arresters complete with accessible isolation valve.

3.3 IDENTIFICATION

- A. Identify Plumbing Piping Specialties as specified in Section "Identification for Plumbing Piping and Equipment".

3.4 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish.

3.5 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 22 21 00

PLUMBING PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pumps for plumbing systems:
 - 1. Booster pumps

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - 2. National Electrical Manufacturer's Association (NEMA)
 - 3. Underwriters Laboratories, Inc. (UL)

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical. Show the following:
 - 1. Vertical and horizontal runs, offsets, and transitions.
 - 2. Clearances for access above and to the side.
 - 3. Show dimensions and details, including connections.
 - 4. Support locations, type of support, and weight on each support.
 - 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
 - 1. Include certified performance curves and rated capacities; shipping, installed, and operating weights; furnished specialties; final impeller dimensions; and accessories for each type of product indicated. Indicate pump's motor efficiency and operating point on curves.

- C. Shop Drawings:
 - 1. Show pump layout and connections. Include Setting Drawings with templates for installing foundation and anchor bolts and other anchorages.
 - a. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
 - b. Submittals shall contain motor performance data, including efficiency, rated horsepower, service factor, rated speed, phase, voltage, frequency, type, frame, and insulation class.
- D. Maintenance Data: For pumps to include in maintenance manuals specified in Division 1.
- E. Closeout Submittals
 - 1. Documentation of pump exercise during storage.
 - 2. Documentation of pump commissioning.
 - 3. Operation and Maintenance Data.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Obtain signed receipt from Owner's Representative.
 - 1. For each pump: One set of all material required for pump re-build (e.g. gaskets and O-rings). Include on mechanical seal for each pump.

1.6 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter
- E. Exercise pumps in storage in accordance with manufacturer's recommendations. Document each occurrence.

1.8 WARRANTY

- A. Provide two-year warranty on parts and labor.

PART 2 - PRODUCTS

2.1 BOOSTER PUMPS

- A. Provide packaged duplex variable-speed centrifugal pump and controller. Pump shall be vertical, multi-stage centrifugal vertical electric pumps. All metal parts in contact with pumped liquid shall be 304 stainless steel. Refer to pump schedule for pump flows, heads, motor speed, enclosure, efficiency and power requirements.
- B. Pump Package
 - 1. Pump package shall include duplex pumps with drives and pressure sensors, shutoff valves, hydropneumatic (diaphragm) tank, and piping manifold. Pump package shall come pre-assembled and tested, complete with operating instructions and panel wiring diagram. Unit shall be provided with a NEMA 4X fused disconnect panel with corrosion resistant durable plastic; external on/off switch with lockout/tagout. Panel shall be bracket-mounted directly to pump. Electrical panel for control and protection, NEMA 4X with fast acting fuses.
 - 2. Each pump shall include a variable-speed drive and controller. Controller shall be a programmable logic controller (PLC). Drives/controllers shall be pre-programmed with pump specific software, designed to match pump output to system conditions while protecting the pump, motor, and pumping system.
 - 3. Motor shall meet NEMA and EISA 2007 specifications, shall be TEFC-type, and shall be of the size, voltage and enclosure shown on plans. Pump and motor shall be factory aligned, and shall be realigned by the contractor per factory recommendations after installation.
 - 4. Pump package shall include pressure sensing devices wired as inputs to the PLC's. Pump shall be arranged to maintain a steady output pressure of psig (adjustable), under variable flow conditions.
 - 5. Pump package shall be sized for maximum operating pressure of 360 PSI and maximum temperature of pump liquid of 180°F.
 - 6. Acceptable manufacturer shall be Goulds Hydrovar SV Packaged Systems, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.
 - 1. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
 - 2. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

- D. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- E. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- F. Verify that ground connections are in place and that installation of grounding described in Electrical Sections is complete.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Install pumps according to manufacturer's written instructions.
- B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so piping is not supported by pumps.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install pressure gages on pump suction and discharge. Install at integral pressure-gage tapings where provided.
- F. Install temperature and pressure-gage connector plugs in suction and discharge piping around each pump.
- G. Install electrical connections for power, controls, and devices.
- H. Electrical power and control wiring and connections are specified in Division 26 Sections.
- I. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 COMMISSIONING

- A. Verify that pumps are installed and connected according to the Contract Documents.

- B. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
- C. Perform the following preventive maintenance operations and checks before starting:
 - 1. Lubricate bearings.
 - 2. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
 - 3. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
 - 4. Verify that pumps are free to rotate by hand and that pumps for handling hot liquids are free to rotate with pumps hot and cold. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
 - 5. Check suction piping connections for tightness to avoid drawing air into pumps.
 - 6. Clean strainers.
 - 7. Verify that pump controls are correct for required application
- D. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
 - 1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
 - 2. Open circulating line valves if pumps should not be operated against dead shutoff.
 - 3. Start motors.
 - 4. Open discharge valves slowly.
 - 5. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
 - 6. Check general mechanical operation of pumps and motors.
 - 7. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.
- E. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.
- F. Refer to the Section "Testing, Adjusting, and Balancing for HVAC" for detailed requirements for testing, adjusting, and balancing hydronic systems.
- G. Document all commissioning efforts.
- H. After pumping systems are commissioned, replace start-up strainers in suction diffusers with permanent strainers.

3.5 INSTALLATION

- A. Install piping, materials and equipment as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.6 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.7 IDENTIFICATION

- A. Identify piping, valves and equipment as specified in Section “Identification of HVAC Piping and equipment”.

3.8 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior “white glove clean”, removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.9 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Plumbing Fixtures as shown on the Contract Drawings.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. Underwriters Laboratories (UL)
 - a. UL 1453 - Electric Booster and Commercial Storage Tank Water Heaters.

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of Plumbing Fixtures with electrical equipment, light fixtures, HVAC equipment and ductwork, and piping.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1.5 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Handle Plumbing Fixtures according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.7 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTER

- A. Reduced pressure zone (RPZ) backflow preventers shall have a relief valve located between two independently operating check valves. Backflow preventers shall be designed for horizontal flow installation and sized as indicated on Contract Drawings. Units shall be provided with air gap drains and selected from the following:
- B. 3/4" thru 2" backflow preventers:
 - 1. Model FRP II as manufactured by Hersey Products Inc.
 - 2. Model 909 as manufactured by Watts Regulator Company.
 - 3. Model 825Y as manufactured by Febco Sales Inc.
 - 4. Or approved equal
- C. 2-1/2" thru 6" backflow preventers:
 - 1. Model 6CM as manufactured by Hersey Products Inc.
 - 2. Model 909 as manufactured by Watts Regulator Company.
 - 3. Model 860 as manufactured by Febco Sales Inc.
 - 4. Or approved equal.

2.2 EMERGENCY EYEWASH/SHOWER WATER HEATING SYSTEM

- A. Manufacturer and Model:
 - 1. Hubbell - Model EMV.
 - 2. Haws Corporation.
 - 3. Bradley Corporation
 - 4. Or approved equal.
- B. Description: Commercial electric water heater designed to provide tepid water for emergency fixtures meeting the requirements of ANSI Z358.1-2004:
 - 1. 120 gallon glass-lined or cement-lined tank with 3" foam insulation. 170°F water storage temperature.
 - 2. Factory piped integral mixing valve.
 - 3. Include optional thermostatic valve required for a re-circulating loop piping system.
 - 4. Factory wired controls.
 - 5. Unit to provide 23 gpm of 85°F water for 15 minutes based on 50°F incoming water.
 - 6. 480 Volt, 3-phase, 6,000 Watt electric heater

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

- B. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install Plumbing Fixtures as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Emergency Plumbing Fixtures shall be installed in accordance with ANSI Z358.1.

3.3 IDENTIFICATION

- A. Identify Plumbing Fixtures as specified in Section "Identification of Plumbing Piping and Equipment".

3.4 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish.

3.5 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.
 - 1. Pipe joint materials.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Fabricated metal equipment supports.
 - 9. Installation requirements common to mechanical specification Sections.
 - 10. Piping joint construction.
 - 11. Cutting and patching.
- B. Pipe and Pipe fitting materials are specified in piping system sections.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. Local Building Codes
 - 2. State Building Codes
 - 3. State Mechanical Code
 - 4. State Plumbing Code
 - 5. State Fire Protection Code
 - 6. American Society of Mechanical Engineers (ASME)
 - 7. American National Standards Institute (ANSI)
 - 8. National Fire Protection Association (NFPA)
 - 9. Underwriters Laboratories (UL)
 - 10. American Society for Testing and Materials (ASTM)
 - 11. American Welding Society (AWS)
 - 12. Occupational Safety and Health Administration (OSHA)
- B. Definitions:
 - 1. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.
 - 2. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
 - 3. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

4. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
5. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
6. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
7. The following are industry abbreviations for plastic materials:
 - a. ABS: Acrylonitrile-butadiene-styrene plastic.
 - b. CPVC: Chlorinated polyvinyl chloride plastic.
 - c. PE: Polyethylene plastic.
 - d. PVC: Polyvinyl chloride plastic.
8. The following are industry abbreviations for rubber materials:
 - a. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - b. NBR: Acrylonitrile-butadiene rubber.

1.3 COORDINATION REQUIREMENTS

- A. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent architectural, structural, mechanical, HVAC, plumbing, and electrical elements. Include new and existing equipment and systems. Show the following:
 1. Vertical and horizontal runs, offsets, and transitions.
 2. Clearances for access above and to the side.
 3. Show dimensions and details, including connections.
 4. Support locations, type of support, and weight on each support.
 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.
- B. Sequencing:
 1. Coordinate mechanical equipment installation with other building components.
 2. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
 3. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
 4. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
 5. Coordinate connection of electrical services.
 6. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

7. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
8. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Coordination Drawings.
- C. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data. Submit product data for following items:
 1. Mechanical sleeve seals.
 2. Transition fittings.
 3. Dielectric fittings.
 4. Escutcheons.
- D. Shop Drawings: detailing fabrication and installation for supports and anchorage for mechanical materials and equipment.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver in shipping splits that can be moved past obstructions in the delivery path.
- B. Coordinate delivery to allow movement into designated space.
- C. Handle components according to manufacturer's written instructions. Use factory-installed lifting provisions.

PART 2 - PRODUCTS

2.1 PIPE JOINING MATERIALS

- A. Refer to individual piping system specification Sections in Division 23 for special joining materials not listed below.
- B. Solder Filler Metal: ASTM B32.
 1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.
 2. Alloy Sn50: Tin (50 percent) and lead (50 percent).
 3. Alloy E: Tin (approximately 95 percent) and copper (approximately 5 percent), having 0.10 percent maximum lead content.
 4. Alloy HA: Tin-antimony-silver-copper-zinc, having 0.10 percent maximum lead content.
 5. Alloy HB: Tin-antimony-silver-copper-nickel, having 0.10 percent maximum lead content.

6. Alloy Sb5: Tin (95 percent) and antimony (5 percent), having 0.20 percent maximum lead content.
- C. Brazing Filler Metals: AWS A5.8.
 1. BcuP Series: Copper-phosphorus alloys.
 2. Bag1: Silver alloy.
- D. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Solvent Cements: Manufacturer's standard solvents complying with the following:
 1. Acrylonitrile-Butadiene-Styrene (ABS): ASTM D2235.
 2. Chlorinated Poly (Vinyl Chloride) (CPVC): ASTM F493.
 3. Poly (Vinyl Chloride) (PVC): ASTM D2564.
 4. PVC to ABS Transition: Made to requirements of ASTM D3138, color other than orange.

2.2 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 1. Manufacturers:
 - a. Eslon Thermoplastics.
 - b. Or approved equal
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 1. Manufacturers:
 - a. Thompson Plastics, Inc.
 - b. Or approved equal.
- C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 1. Manufacturers:
 - a. Hayward
 - b. Or approved equal.
- D. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.
 - e. Or approved equal.

2.3 DIELECTRIC FITTINGS

A. Manufacturers:

1. Capitol Manufacturing Co.
2. Central Plastics Company.
3. Eclipse, Inc.
4. Epco Sales, Inc.
5. Hart Industries
6. International, Inc.
7. Watts Industries, Inc.
8. Water Products Div.
9. Zurn Industries, Inc.
10. Wilkins Div.
11. Or approved equal

B. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

C. Performance/Design Criteria:

1. Insulating Material: Suitable for system fluid, pressure, and temperature.
2. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

D. Materials and Construction:

1. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
 - a. Manufacturers:
 - 1) Capitol Manufacturing Co.
 - 2) Central Plastics Company.
 - 3) Epco Sales, Inc.
 - 4) Watts Industries, Inc.; Water Products Div.
 - 5) Or approved equal.
2. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and stainless steel backing washers.
 - a. Manufacturers:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) Pipeline Seal and Insulator, Inc.
 - 5) Or approved equal.
 - b. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
3. Dielectric Couplings: Stainless steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - a. Manufacturers:
 - 1) Calpico, Inc.
 - 2) Lochinvar Corp.

- 3) Or approved equal.
4. Dielectric Nipples: Stainless steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - a. Manufacturers:
 - 1) Perfection Corp.
 - 2) Precision Plumbing Products, Inc.
 - 3) Sioux Chief Manufacturing Co., Inc.
 - 4) Victaulic Co. of America.
 - 5) Or approved equal.

2.4 SLEEVES

- A. Materials and Construction:
 1. Stainless Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
 2. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, Type 316 stainless steel, plain ends.
 3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
 4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with set screws.
 5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
 6. PVC Pipe: ASTM D1785, Schedule 40.
 7. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Or approved equal
- B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- C. Materials and Construction:
 1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Stainless steel. Include two for each sealing element.
 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. Materials and Construction:
 - 1. One-Piece, Stainless Steel Type: With set screw or spring clips and chrome-plated finish.
 - 2. Split-Plate, Stamped-Steel Type: With exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.
 - 3. One-Piece, Floor-Plate Type: Cast-iron floor plate.
 - 4. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

- A. Description: ASTM C1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
- B. Materials and Construction:
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.8 FABRICATED METAL SUPPORTS

- A. Structural Steel Shapes: ASTM A36.

2.9 SHOP FINISHES

- A. Finish: ANSI 61 light gray paint.
- B. With the exception of those parts and components customarily furnished unpainted, prepare and coat all metal surfaces with rust inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified.
- C. Protect machined surfaces against damage and corrosion by other means.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.

- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Mechanical Installations
 - 1. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
 - a. Coordinate mechanical systems, equipment, and materials installation with other building components.
 - b. Verify all dimensions by field measurements.
 - c. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 - d. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - e. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - f. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - g. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - h. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Owner's Representative.
 - i. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
 - j. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
 - k. Install access panel or doors where units are concealed behind finished surfaces.
 - l. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

C. Piping Installation

1. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 23 specify piping installation requirements unique to the piping system.
2. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.
3. Install piping at indicated slope.
4. Install components having pressure rating equal to or greater than system operating pressure.
5. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
6. Install piping free of sags and bends.
7. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.
8. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
9. Install piping to allow application of insulation plus 3-inch clearance around insulation.
10. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
11. Install fittings for changes in direction and branch connections.
12. Install couplings according to manufacturer's printed instructions.
13. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings in finished areas.
14. Verify final equipment locations for roughing in. Refer to equipment specifications in other Sections for roughing-in requirements.
15. Angle (wye) type strainers shall be provided with shutoff valve and cap on blowdown connection.
16. Where mains are reduced, provide eccentric reducing fittings installed with flat side on the bottom.
17. Horizontal piping shall not be installed less than 6 inches above finished floor (along walls), less than 7 ft-6 inches above finished floor (other areas), or in front of windows.
18. Piping shall be offset, relocated, or changed to clear ducts, beams, conduits and other obstacles.
19. Piping systems shall be free of noise and vibration under normal operating conditions.
20. Install piping to permit valve servicing.
21. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.

- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
- e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
- f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
- g. Bare Piping in Unfinished Service Spaces: Non escutcheon.
- h. Bare Piping in Equipment Rooms: No escutcheon.
- i. Bare Piping at Floor Penetrations in Equipment Rooms: No escutcheon.

D. Sleeves

- 1. Install sleeves for pipes passing through concrete and masonry walls, fire-rated partitions, concrete floor and roof slabs, and where indicated.
 - a. Cut sleeves to length for mounting flush with both surfaces.
 - 1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.
 - b. Build sleeves into new walls and slabs as work progresses.
 - c. Install large enough sleeves to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - 1) Steel Pipe Sleeves: For pipes smaller than 6 inches.
 - 2) Steel Sheet-Metal Sleeves: For pipes 6 inches and larger that penetrate gypsum-board partitions.
 - 3) Cast Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - d. Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.
 - e. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants specified in Division 7 Section "Joint Sealants."
 - f. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.
 - 1) Install steel pipe for sleeves smaller than 6 inches.
 - 2) Install cast-iron wall pipes for sleeves 6 inches and larger.
 - 3) Assemble and install mechanical seals according to manufacturer's printed instructions.
 - g. Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron wall pipes for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.
 - h. Below Grade, Exterior Wall, Pipe Penetrations: Install ductile-iron wall penetration system sleeves according to manufacturer's printed installation instructions.
 - i. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping sealant material. Firestopping materials are specified in Division 7 Section Penetration Firestopping.

2. Sleeves are not required for core-drilled holes.

E. Piping Joint Construction

1. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - a. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - b. ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendices.
 - c. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 - d. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
 - e. PVC Nonpressure Piping: Join according to ASTM D2855.
 - f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D3138 Appendix
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
11. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.
12. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
 - a. Plain-End Pipe and Fittings: Use butt fusion.
 - b. Plain-End Pipe and Socket Fittings: Use socket fusion.
13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

F. Piping Connections

1. Piping Connections: Except as otherwise indicated, make piping connections as specified below.
 - a. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a threaded pipe connection.
 - b. Install flanges in piping 2-1/2 inches and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
 - c. Dry Piping Systems (Gas, Compressed Air, and Vacuum): Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - d. Wet Piping Systems (Water and Steam): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
 - 1) Where copper tube is joined to steel pipe, a section of brass pipe or a brass valve may be substituted for a dielectric fitting.

G. Equipment Installation – Common Requirements

1. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.
2. Install equipment according to submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Owner's Representative.
3. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.
4. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
5. Install equipment giving right-of-way to piping systems installed at a required slope.

H. Painting and Finishing

1. Refer to The Section Painting for field painting requirements.
2. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

I. Fabrication and Erection of Metal Equipment Supports and Anchorage

1. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical equipment.
2. Field Welding: Comply with AWS D1.1 "Structural Welding Code – Steel."

J. Cutting and Patching

1. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
2. Repair cut surfaces to match adjacent surfaces.

K. Grouting

1. Install nonmetallic nonshrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.
2. Clean surfaces that will come into contact with grout.
3. Provide forms for placement of grout, as required.
 - a. Avoid air entrapment when placing grout.
 - b. Place grout to completely fill equipment bases.
4. Place grout on concrete bases to provide a smooth bearing surface for equipment.
5. Place grout around anchors.
6. Cure placed grout according to manufacturer's printed instructions.

3.3 PAINTING

- A. Perform field painting in accordance with the Section "Painting."

3.4 IDENTIFICATION

- A. Identify piping, valves, equipment as specified in Section "Identification of HVAC Piping and Equipment."

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.6 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 05 19

METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes direct reading, bourdon tube pressure gauges for liquid, compressed air or gas service and thermometers for liquid in pipes, as shown on the Contract Drawings or as specified, complete with accessories.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. American National Standards Institute (ANSI)

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical. Show the following:
 - 1. Vertical and horizontal runs, offsets, and transitions.
 - 2. Clearances for access above and to the side.
 - 3. Show dimensions and details, including connections.
 - 4. Support locations, type of support, and weight on each support.
 - 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- C. Closeout Submittals
 - 1. Operation and Maintenance Data.
 - 2.

1.5 QUALITY ASSURANCE

- A. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Coordinate delivery to allow movement into designated space.
- B. Store in clean dry indoor rooms.
- C. Handle components according to manufacturer's written instructions. Use factory-installed lifting provisions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 1. Ashcroft
 2. Ametek/US Gauge
 3. Trerice
 4. Or approved equal

2.2 GENERAL

- A. Gauges shall be provided with ¼ inch ball valve with tee handle and pulsation dampeners unless otherwise shown.
- B. Gauges of like type shall be the product of one manufacturer.
- C. All gauges shall be 4 1/2 inch size unless otherwise shown.

2.3 MATERIALS AND CONSTRUCTION

- A. Cases
 1. Cases shall be aluminum, stainless steel or phenolic.
 - a. Finish shall be black except for stainless steel.
 2. Cases shall include heavy acrylic dial covers.
 3. 4 1/2 inch and larger gauges shall have flanges for wall or flush mounting.
- B. Bourdon Tubes
 1. Bourdon tubes shall be bronze unless otherwise specified.
- C. Accuracy
 1. Accuracy of gauges 4 1/2 inch and larger shall be 1% of full scale.
 2. Accuracy of gauges smaller than 4 1/2 inch shall be 2% of full scale.
- D. Movements

1. Movements shall be brass or stainless steel, and shall be adjustable for recalibration.
 - E. Ball Valves
 1. Ball valves shall be brass with tee handles, rated for system temperature and pressure.
 - F. Pulsation Dampeners
 1. Pulsation dampeners shall be brass construction, and shall be adjustable by pin size or pin location.
 - G. Diaphragm Seals
 1. Diaphragm seals shall have stainless steel housing and 316 stainless steel diaphragm.
 2. Glycerine or silicone filled gauges shall be factory assembled.
 - H. Scale
 1. Scale of Gauge: Mid point shall be nominal system operating pressure.
 2. Submit scale schedule, per application, for approval.
- 2.4 DIRTY FILTER GAGE
- A. Service: Air and non-combustible, compatible gases.
 - B. Housing: Die cast aluminum case and bezel, with acrylic cover, Exterior finish is coated gray to withstand 168 hour salt spray corrosion test.
 - C. Accuracy: $\pm 2\%$ throughout range at 70°F.
 - D. Pressure Limits: -20 in Hg. to 15 psig.
 - E. Overpressure: Relief plug opens at approximately 25 psig (1.72 bar), standard gages only.
 - F. Temperature Limits: 20 to 140°F.
 - G. Mounting Orientation: Diaphragm in vertical position.
 - H. Process Connections: 1/8" female NPT duplicate high and low pressure taps - one pair side and one pair back.
 - I. Range shall be selected such that the range of operating pressures is within 25-75% of full scale.
 - J. Unit shall be Series 2000 Magnehelic Differential Pressure Gage as manufactured by Dwyer, or equal.

2.5 THERMOMETERS

- A. Nine inch scale, adjustable angle, blue fluid, cast aluminum case, stainless steel stem, scale range in °F shall be such that the operating temperature range is within 25-75% of the top of the scale. Unit shall be BX9 as manufactured by Terice, or equal.
 - 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Gauges 4 1/2 inch or larger, where not panel or wall mounted, shall be supported by suitable brackets.
- B. Gauges shall be protected until acceptance.
- C. Provide ball valves at each pressure gauge along with pulsation dampener. Provide diaphragm seals as noted on drawings/details.
- D. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.3 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.4 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.5 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes hangers, supports, and restraints for HVAC systems including piping, ductwork, and equipment as shown on the Contract Drawings.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
- B. American Society of Mechanical Engineers (ASME):
 - 1. ASME B31.1 – Power Piping Code
 - 2. ASME B31.9 – Building Services Piping
 - 3. ASME Boiler and Pressure Vessel Code
- C. Manufacturers Standardization Society (MSS):
 - 1. MSS SP-58 Materials and Design of Pipe Supports
 - 2. MSS SP-69 Selection and Application of Pipe Supports
 - 3. MSS SP-89 Fabrication and Installation of Pipe Supports
- D. American Society for Testing and Materials (ASTM):
 - 1. ASTM A167 – Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - 2. ASTM A480 – Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - 3. ASTM A653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.
 - 4. ASTM A924 – Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot Dip Process.
 - 5. ASTM B209 – Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 6. ASTM C1107 – Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- E. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):
 - 1. SMACNA "HVAC Duct Construction Standards."

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between

equipment and adjacent structural, mechanical, HVAC, and electrical. Show the following:

1. Vertical and horizontal runs, offsets, and transitions.
2. Clearances for access above and to the side.
3. Show dimensions and details, including connections.
4. Support locations, type of support, and weight on each support.
5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- D. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.
 1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

1.5 QUALITY ASSURANCE

- A. Qualifications
 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All components shall be stainless steel construction for corrosion resistance.
- B. All components of like size and type shall be the product of the same manufacturer for purposes of parts interchangeability.

2.2 MISCELLANEOUS MATERIALS

- A. Structural steel:

1. Stainless steel, Type 316, ASTM A276.

B. Grout: ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)MEMBERS

2.3 UPPER HANGER ATTACHMENTS

A. Standard-Duty Beam Clamps (for piping): Stainless steel jaw, stainless steel tie-rod, nuts, and washer. Underwriters Laboratories (UL) listed, Factory Mutual approved

B. Heavy-Duty Beam Clamps (for large pipe and equipment): Stainless steel

C. Welded Structural Attachments: carbon steel

D. Brace Fitting: Stainless steel bracket and pipe end, hex-head cap screw and nut

E. Wall Brackets: Factory-fabricated stainless steel bracket with knee brace

F. Concrete Inserts (for new upper deck construction only):

1. Stainless steel inserts, threaded for rod.

2. Stainless steel inserts with lateral adjustment capability

G. Concrete Attachments for existing concrete upper decks: stainless steel plate with factory-drilled and anchor holes and factory-welded rod attachments

2.4 FASTENERS

A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

2.5 RODS

A. Rods: Stainless steel, continuous thread or end thread.

B. Nuts, Bolts, and Washers: Stainless steel.

2.6 PIPE SUPPORTS AND RESTRAINTS

A. Adjustable Swivel Ring: 3/4-inch through 8-inch pipe, Underwriters Laboratories (UL) listed, Factory Mutual (FM) approved, MSS SP-69, Anvil figure 104.

B. Clevis Hanger: Adjustable clevis, Underwriters Laboratories (UL) listed, Factory Mutual (FM) approved, Anvil figure 260, 300 and 590.

C. Roll Hangers: Adjustable pipe roll hangers, Anvil figure 181.

D. Roll Supports: Anvil figures 171, 175, 177, 271, 274, and 277.

- E. Pipe Guides: Unless otherwise indicated, guides shall be spider clamp, sized for insulation, Anvil figure 256.
- F. Insulation Protection Saddle: galvanized steel protection saddle shall prevent crushing of insulation by transmitting hanger contact load to pipe while minimizing heat transfer. Saddle shall be a minimum of 12 inches long and shall cover a 60 degree arc. Anvil figures 160 through 164.
- G. Insulation Protection Shield: Sheetmetal protection shield shall prevent crushing of insulation by spreading hanger contact load while minimizing heat transfer. Shield shall be a minimum of 12 inches long and cover a 180 degree arc. Anvil figure 167.
- H. Riser clamps: Anvil figures 261 and 40.

2.7 DUCTWORK HANGERS

- A. Sheetmetal Straps:
 - 1. Stainless steel: ASTM A 527, lock-forming quality; and ASTM A525, coating designation G-90.
 - 2. Aluminum: ASTM B209, alloy MLA with H-14 temper.
 - 3. Stainless steel: ASTM A167, Type 302, 304, or 316; and ASTM A480, finish no. 1 or no. 4.
 - 4. Material shall match ductwork.
- B. Fasteners:
 - 1. Sheetmetal screws: material to match sheetmetal
 - 2. Bolts and nuts: stainless steel, hex-head.
- C. Fabricate ductwork hangers in accordance with SMACNA "HVAC Duct Construction Standards."

PART 3 - EXECUTION

3.1 GENERAL

- A. Hang, support, and restrain mechanical work from structural work. Do not hang, support, or restrain mechanical work from electrical work or from other mechanical work. Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Vertical Piping:
 - 1. Support vertical risers of piping systems by means of heavy duty hangers installed close to base of pipe risers, and by riser clamps with extension arms at intermediate floors, with the distance between clamps not to exceed 25feet, unless otherwise specified. Support pipe risers in vertical shafts equivalent to the aforementioned. Install riser clamps above floor slabs, with the extension arms resting on floor slabs or pipe sleeves. Provide adequate clearances for risers that are subject to appreciable expansion and contraction caused by operating temperature ranges.

2. Support for extension arms of riser clamps which are secured to risers to be insulated for cold service shall be 4 inches above floor slabs, to allow room for insulation and vapor sealing around riser clamps.
- C. Use clevis hangers for horizontal runs less than 20 feet long.
- D. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- E. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.

3.2 MATERIALS OF CONSTRUCTION

- A. Hangers and supports installed in process areas shall be constructed from stainless steel. Process areas include, but are not limited to, the following:
1. Fine Screening Building
 2. Plant Effluent Pump Station
 3. Primary Sludge Pump Station
 4. Biological Treatment
 5. Secondary Gallery and associated tunnels
 6. Vestibules
 7. Digester Control Building and associated tunnels
 8. Solids Handling Building
 9. Outdoors.
- B. Hangers and supports installed in non-process areas shall be constructed from carbon steel. Non-process areas include the Administration Building.

3.3 HANGER SCHEDULE

- A. Natural Gas Piping
1. 3/4 inch to 2 inch - Adjustable ring, stainless steel.
 2. 2-1/2 inch to 6 inch - Adjustable clevis, stainless steel. Where installed on pipe rack, provide roller support.

- B. Digester Gas Piping
 1. 3/4 inch to 2 inch - Adjustable ring, stainless steel
 2. 2-1/2 inch to 6 inch - Adjustable clevis, stainless steel. Where installed on pipe rack, provide stainless steel roller support.
- C. Plant Effluent Water
 1. 3/4 inch to 2 inch – Adjustable ring, black for steel pipe, copper plated for copper pipe.
 2. 2 inch to 6 inch – Adjustable clevis, wrought carbon steel, black for steel pipe, copper-plated for copper pipe. Where installed on pipe rack, provide roller support.
- D. Hot Water
 1. 3/4 inch to 2 inch – Adjustable ring, wrought carbon steel, black for steel pipe, copper plated for copper pipe.
 2. 2 inch to 6 inch – Adjustable clevis, wrought carbon steel, black for steel pipe, copper-plated for copper pipe. Where installed on pipe rack, provide roller support.

3.4 PIPE HANGER SPACING

- A. Space hangers or supports for horizontal piping on maximum center distances as listed in the following hanger schedules, except as otherwise specified, or noted on the Drawings.
- B. Spacings do not apply where concentrated loads are placed between supports. Concentrated loads include flanges, valves, and specialties.
- C. For Schedule 40 steel pipe carrying air, gas (except fuel gas), or steam; or liquid with specific gravity less than or equal to 1.0; at pressures from 0 to 125 psig and temperatures from 0 to 250 deg F:

Pipe Size	Spacing
1/2 inch	7 feet
3/4 inch	7 feet
1 inch	7 feet
1-1/2 inch	9 feet
2 inch	10 feet
2-1/2 inch	11 feet
3 inch	12 feet
4 inch	14 feet
6 inch	17 feet
8 inch	19 feet
10 inch	20 feet
12 inch	23 feet
16 inch	27 feet
20 inch	30 feet
24 inch	32 feet

- D. For steel or stainless steel pipe carrying fuel gas: Space hangers or supports on maximum centers of 6 feet for 1/2 inch pipe size; 8 feet for 3/4 inch and 1 inch pipe sizes; and 10 feet for 1-1/4 inch pipe size and above.
- E. CPVC pipe operating above 70 deg F shall have continuous support.
- F. For Directional Changes: Install a hanger or support close to the point of change of direction of all pipe runs in either a horizontal or vertical plane.
- G. For Concentrated Loads: Install additional hangers or supports, spaced as required and directed, at locations where concentrated loads such as in-line pumps, valves, fittings or accessories occur, to support the concentrated loads.
- H. For Branch Piping Runs and Runouts over 5 feet in Length: Install a minimum of one hanger, and additional hangers if required by the hanger spacing schedules.
- I. Parallel Piping Runs: Where several pipe lines run parallel in the same place and in close proximity to each other, trapeze hangers may be submitted for approval. Base hanger spacing for trapeze type hangers on the smallest size of pipe being supported. Design the entire hanger assembly based on a safety factor of five, for the ultimate strength of the material being used.
- J. Support floor drain traps from the overhead construction, with hangers of type and design as required. Over-head supports are not required for floor drain traps in-stalled directly below earth supported concrete floors.

3.5 ANCHORS, RESTRAINTS, RIGID SUPPORTS, STAYS AND SWAY BRACES

- A. Install pipe anchors, restraints and sway braces, at locations noted on the Drawings. Design anchors so as to permit piping to expand and contract freely in opposite directions, away from anchor points. Install anchors independent of all hangers and supports, and in a manner which will not affect the structural integrity of the building.

3.6 EQUIPMENT HANGERS

- A. Provide vibration isolating hangers for equipment with motors.
- B. Support air terminal units independent of ductwork.
- C. Support slot diffusers independent of suspended ceiling grid.

3.7 RODS

- A. Pipe and duct hanger rods shall be full size to match hangers.
- B. Trapeze and equipment hanger rods shall be sized for maximum load with a safety factor of five.
- C. Provide two nuts at each end of rods for positioning rod and hanger and locking each in place.

3.8 UPPER HANGER ATTACHMENTS

A. General

1. Upper hanger attachments shall be made to structural steel wherever possible.
2. Powder-driven drive pins shall not be used.
3. Expansion nails shall not be used.
4. Powder-driven fasteners shall not be used in precast concrete.
5. Loads in excess of 250 pounds shall not be supported from a single welded or powder-driven stud.

B. Steel Frame Construction

1. Provide intermediate structural steel members where required by ductwork support spacing. Select members based on a minimum safety factor of five.
2. Secure upper hanger attachments to steel bar joists within 6 inches of panel points, or provide intermediate strut to transfer load to top chord of joist.
3. Holes shall not be drilled in structural steel members.
4. Friction clamps shall not be used.

3.9 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 1. Systems are within the limitations established by the manufacturer.
 2. Each utility pipe and conduit is in the correct location.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.10 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following as shown on the Contract Drawings.
 - 1. Pipe Identification Painting.
 - 2. Pipe Identification Markers and Tags.
 - 3. Valve Identification.
 - 4. Duct Identification.
 - 5. Equipment Identification.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
- B. American National Standards Institute (ANSI)
 - 1. ANSI A13.1 - Scheme for the Identification of Piping Systems.

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: Catalog cuts and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- C. Submit, for review, samples of symbols and abbreviations, letter size, color for coding, and a complete list of legend wording proposed for mechanical identification. Do not order or purchase identification materials until samples have been reviewed.
- D. Quality Control Submittals
 - 1. Submit manufacturer's installation instructions.
 - 2. Submit, for review, sample format for valve service identification chart(s) containing (as a minimum) the following information:
 - a. Valve tag number.
 - b. Valve location.
 - c. Valve function and service.
 - d. Valve manufacturer's name and model number.

- E. Contract Closeout Submittals
 - 1. Submit final valve service identification chart(s), framed as specified below.

1.5 QUALITY ASSURANCE

- A. Identifying labels and markings for piping shall conform to ANSI A13.1 for legend, color, visibility, and size of legend and letters.
- B. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.6 SEQUENCING AND SCHEDULING

- A. Complete all testing, insulation, and finish painting prior to executing the Work of this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Description:
 - 1. Pipe Identification Markers:
 - a. Snap-On Type: Precoiled acrylic plastic marker with clear polyester coating, incorporating flow arrows, and legend printed in alternate directions.
 - 1) Piping or insulation under 6 inch O.D.: One piece wrap around type with 3/4 inch adhesive strip on inside edge and 360 degree visibility.
 - 2) Piping or insulation 6 inch O.D. and larger: Strip type with factory applied grommets, secure with stainless steel spring fasteners.
 - b. Stick-On Type: One piece pressure sensitive adhesive backed plastic marker with clear polyester coating, incorporating flow arrows and legend printed in alternate directions.
 - 1) Piping or insulation under 8 inch O.D.: Wrap around type with 360-degree visibility.
 - 2) Piping or insulation 8 inch O.D. and larger: Strip type.
 - c. Markers shall be color coded based on pipe contents. Color selection shall be according to chart in Part 3 of this Section.
- B. Materials and Construction:
 - 1. Pipe Banding Tape:
 - a. 1-1/2 inch width (minimum), pressure sensitive adhesive backed type, of same material as pipe identification marker, and of color to match background color of pipe identification marker.
 - 2. Pipe Service Identification Tags:
 - a. Type: Brass, 19 B&S gage, with 1/4 inch high pipe service abbreviated lettering over 2-inch high pipe size lettering. Lettering shall be deep stamped and black filled. Tag to have 3/16 inch diameter hole at top for fastening.
 - b. Size: 2 inch square tag.

- c. Fasteners: Brass “S” hook or brass jack chain, size as required for pipe to which tag is attached.
- 3. Valve Identification Tags:
 - a. Type: Brass, 19 B&S gage, with 1/4 inch high valve service abbreviated lettering over 2-inch high lettering indicating valve service chart number. Lettering shall be deep stamped and black filled. Tag to have 3/16 inch diameter hole at top for fastening.
 - b. Size:
 - 1) Utilities: 1-1/2 inch diameter round tag.
 - 2) Plumbing: 1-1/2 inch hexagon tag.
 - c. Fasteners: Brass “S” hook or brass jack chain, size as required for valve stem or handle to which tag is attached.
- 4. Duct and Equipment Identification Letters & Numbers:
 - a. Type: Stick-on type, made of all purpose polyester, single character letters and numbers, specifically designed for outdoor use.
 - b. Color: Black letters on bright yellow background.
 - c. Size: Letters and numbers shall be 1 inch or 3 inches in height, as specified.

2.2 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 - 1. Seton Identification Company, Branford, Connecticut.
 - 2. Brady Corporation, Milwaukee, Wisconsin.
 - 3. Or approved equal

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer’s installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- C. Verify that ground connections are in place and that installation of grounding described in Section “Grounding” is complete.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPE IDENTIFICATION PAINTING

- A. Bare (un-insulated) piping shall be painted with various colors to identify the contents. Paint colors shall be coordinated with piping contents and existing plant piping colors. Painting shall include color coding and identification by stenciled lettering
- B. Pipe Painting Color Code Schedule: Refer to Section entitled “Painting.”

3.3 PIPE IDENTIFICATION MARKERS AND TAGS

A. General:

1. Small piping and insulated piping shall be identified as to content and direction of flow by use of pipe identification markers or tags.
2. Identify all piping, bare or insulated, whose contents match those listed in the Pipe Identification Schedule (Paragraph F, below), with the following exceptions:
 - a. Piping in furred spaces or above plastered ceilings, except at access panels where valves and piping shall be identified as specified for exposed piping.
 - b. Piping in finished spaces such as offices, toilet rooms, locker rooms, etc.
3. Marker legend size, field color, and length of field shall be in accordance with ANSI A13.1.
4. Legend wording shall be developed by the Contractor and submitted for review. Whenever possible, standard terminology should be used. Identification by the combination of two or more standard labels (at each identification point) is acceptable.

B. Use of Markers or Tags:

1. Pipe or insulation with an outside diameter (O.D.) of 3/4 inch and less shall be identified by the use of Pipe Service Identification Tags.
2. Pipe or insulation with an O.D. larger than 3/4 inch shall be identified by the use of Pipe Identification Markers.
3. Either snap-on or stick-on type markers may be used; except that stick-on markers shall not be used in the following situations:
 - a. Areas where humid, wet, or dripping conditions are found or likely.
 - b. Areas where chemical fumes are present or likely.
 - c. Outdoor installations.
 - d. On lines subject to 50 degree F temperature variations.

C. Location of Markers and Tags:

1. Pipe markers and tags shall be located so as to be readily visible from any reasonable point of observation.
2. Locate identification at all valves, branch or riser take-offs, and both sides of pipe passage through walls, floors, and ceilings.
3. On continuous pipe runs locate identification at 20 foot intervals, but not less than one marker or tag on any length of 10 feet or greater.

D. Preparation:

1. Insure that any painting is complete and the paint has thoroughly dried before applying identification.
2. Prepare surface in accordance with the manufacturer's instructions for the type of identification used and the surface to which it is applied.

E. Installation:

1. Install markers and tags in accordance with the manufacturer's instructions.
2. Secure both ends of stick-on type markers with 360-degree application of pipe banding tape. Tape shall have one inch lap on pipe or insulation.

- F. Pipe Identification Schedule: Identify the following types of piping with markers and/or tags.

Pipe Service	Label Abbreviation	Background Color	Letter Color
Cooling Tower Water Supply	CTWS	Green	White
Cooling Tower Water Return	CTWR	Green	White
Heat Pump Water Supply	HPWS	Yellow	Black
Heat Pump Water Return	HPWR	Yellow	Black
Natural Gas	GAS	Yellow	Black

3.4 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.5 VALVE IDENTIFICATION

- A. General:
- Valves specified below shall be designated by distinguishing numbers and/or letters.
 - Where applicable, valve designation shall match (as closely as possible) the designation found on the Contract Drawings.
- B. Installation:
- Fasten tags to valve stems or handles using brass "S" hooks or jack chain.
 - Fasten tags in a manner and location that will permit easy reading, but will not interfere with the operation of the valve.
- C. Valve Service Identification Chart:
- Provide two framed valve charts for each piping system to have valve identification tags.
 - Charts shall be typed, in the reviewed format, on 8-1/2 x 11 inch heavy white bond paper and framed in an aluminum frame.
 - Hang framed charts at location(s) directed.

3.6 DUCT IDENTIFICATION

- A. General:
- Ductwork shall be identified as to type of air being conveyed and, where specified, the air handling unit to which it is connected by use of stick-on letters and numbers.
 - Identify bare or insulated interior ductwork (outdoor ductwork does not require labeling) in the following locations:
 - Mechanical Equipment Rooms.
 - Penthouses.
 - Ductwork penetrating the roof (below the roof).

B. Location and Content of Identification:

1. Locate identification at ductwork connections to equipment and at ductwork roof penetrations.
2. Assemble letters to identify air within the duct as one of the following:
 - a. "SUPPLY AIR"
 - b. "RETURN AIR"
 - c. "EXHAUST AIR"
 - d. "OUTSIDE AIR"
 - e. "FUME EXHAUST"
3. In addition, at roof penetrations, include the equipment identification number to which or from which the penetrating duct is connected. For example:
4. "EXHAUST AIR" or "SUPPLY AIR"
5. "TO EF-12A" "FROM ACU-301"
6. Horizontal ductwork shall have lettering on opposite sides, along centerline of the duct at each point of identification. Where view of vertical sides is obstructed, apply lettering to be visible from bottom and/or top of duct.
7. Vertical ductwork shall have lettering applied on the two most visible sides, oriented to read from the bottom upward, along the centerline of the duct.

C. Size of Lettering:

1. 12 inch or less duct or insulation dimension (or diameter) to which the lettering is applied: 1 inch high lettering.
2. Greater than 12 inch duct or insulation dimension (or diameter) to which the lettering is applied: 3 inch high lettering.

D. Installation:

1. Prepare surface to which lettering is applied and install lettering in accordance with the manufacturer's instructions.
2. Apply lettering in a straight line along the axis of the duct. Lettering edges should touch, but not overlap.

3.7 EQUIPMENT IDENTIFICATION

A. General:

1. Identify mechanical equipment, bare or insulated, in the following locations, by use of stick-on letters and numbers:
 - a. Mechanical Equipment Rooms.
 - b. Boiler rooms.
 - c. Penthouses.
 - d. Suspended ceiling plenums.
 - e. Roof mounted equipment.

B. Location and Content of Identification:

1. Equipment shall be identified with a minimum of two sets of lettering. Center identification lettering, vertically and horizontally, on opposite vertical sides of the equipment.
2. Vertical sides selected shall have the longest dimension (i.e., label sides of equipment and not the ends), unless view is obstructed to those sides. If view is obstructed to sides of equipment, locate identification lettering on the two most visible vertical sides and/or ends.

3. Equipment identification numbers and letters shall match the designation found in the equipment schedules on the Contract Drawings.
- C. Size of Lettering:
1. Use the largest lettering size (3 inch or 1 inch height) that will easily fit the available surface space.
 2. Use only one lettering height on any given piece of equipment (i.e., do not mix lettering sizes).
- D. Installation:
1. Prepare surface to which lettering is applied and install lettering in accordance with the manufacturer's instructions.
 2. Apply lettering in a straight line along the axis of the equipment. Lettering edges should touch, but not over-lap.
- 3.8 CLEANING
- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.
- 3.9 PROTECTION
- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
 - 1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
 - 2. Adjusting total HVAC systems to provide indicated quantities.
 - 3. Measuring electrical performance of HVAC equipment.
 - 4. Setting quantitative performance of HVAC equipment.
 - 5. Verifying that automatic control devices are functioning properly.
 - 6. Reporting results of the activities and procedures specified in this Section.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. Associated Air Balance Council (AABC).
 - 2. Air Movement and Control Association (AMCA).
 - 3. Cooling Tower Institute (CTI).
 - 4. National Environmental Balancing Bureau (NEBB).
 - 5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.3 PROJECT CONDITIONS

- A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.
- B. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.4 COORDINATION REQUIREMENTS

- A. Coordinate with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.
- C. Notice: Provide 7 days advance notice to Owner's Representative for each test. Include scheduled test dates and times.

- D. Witness and signoff by Owner's Representative is required.
- E. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.5 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
- C. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.
- D. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.
- E. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
- F. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.
- G. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.
- H. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- I. Close-Out Submittals: Submit copy of each final test, adjust, and balance report to the Owner.

1.6 QUALITY ASSURANCE

- A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.
- B. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other

support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. Contract Documents examination report.
 - c. Testing, adjusting, and balancing plan.
 - d. Work schedule and Project site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
 1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
 2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
- D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems
- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards or as described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

1.7 WARRANTY

- A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. National Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms stating that AABC will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents.
- C. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:
 1. The certified Agent has tested and balanced systems according to the Contract Documents.
 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.
- C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- E. Report Forms: Test data sheets for recording test data in logical order.
- F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- K. Test: A procedure to determine quantitative performance of a system or equipment.
- L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

3.2 EXAMINATION

- A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
 - 1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
 - 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of

these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine project record documents described in Division 1 Section "Project Record Documents."
- D. Examine Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine strainers for clean screens and proper perforations.
- K. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.
- L. Examine equipment for installation and for properly operating safety interlocks and controls.
- M. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices operate by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.

4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
 5. Sensors are located to sense only the intended conditions.
 6. Sequence of operation for control modes is according to the Contract Documents.
 7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 8. Interlocked systems are operating.
- N. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures. Report the status of each component listed in the examination in paragraph M above.
- O. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- P. Examine roughing-in systems to verify the following:
1. Systems are within the limitations established by the manufacturer.
 2. Each utility pipe and conduit is in the correct location.
- Q. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.
- R. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

- A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Isolating and balancing valves are open and control valves are operational.

3.4 GENERAL TESTING AND BALANCING PROCEDURES

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards and this Section or perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

- C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.5 CONSTANT-VOLUME AIR SYSTEMS – BALANCING PROCEDURES

- A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for process exhaust-air systems. These additional procedures are specified in other articles in this Section.
- B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each air-handling unit component.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.
 - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 - 5. Adjust fan speed higher or lower than design with the approval of the Engineer. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 - 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.
- C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.
 - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

- D. Measure terminal outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.
- E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.
 - 1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts or as indicated on the Contract Documents.

3.6 AIR HANDLING UNITS

- A. Record drawing, design and field test static pressure, in order of physical arrangement, for each applicable system component; i.e., louver, filter, preheat coil, cooling coil, etc., and the most remote terminal unit. With controls functioning properly and proper water flow rates, test and record air dry bulb and wet bulb temperature of entering outside air, return air, mixed air, supply air, and air entering and leaving each coil for each air handling unit. Where feasible, measure air dry bulb and wet bulb temperatures with the mechanically aspirated psychrometer. All filters shall be clean and in place before starting fans. All air filters shall be artificially loaded, by partial blanking or other means, to produce air pressure drop midway between clean and dirty. Controls and dampers shall be set for normal full air flow testing and balancing.

3.7 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check expansion tank liquid level.
 - 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation and set at design flow.
 - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.
 - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 HYDRONIC SYSTEMS – BALANCING PROCEDURES

- A. Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:
 - 1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.
 - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.
 - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 - 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.
- E. Adjust balancing stations to within specified tolerances of design flow rate as follows:
 - 1. Determine the balancing station with the highest percentage over design flow.
 - 2. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
 - 3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.9 PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS – ADDITIONAL PROCEDURES

- A. Balance the primary system crossover flow first, then balance the secondary system.

3.10 MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer, model, and serial numbers.
 - 2. Motor horsepower rating.

3. Motor rpm.
4. Efficiency rating if high-efficiency motor.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

3.11 COOLING TOWERS

- A. Shut off makeup water for the duration of the test, and then make sure the makeup and blow-down systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:
 1. Measure condenser water flow to each cell of the cooling tower.
 2. Measure entering- and leaving-water temperatures.
 3. Measure wet- and dry-bulb temperatures of entering air.
 4. Measure wet- and dry-bulb temperatures of leaving air.
 5. Measure condenser water flow rate recirculating through the cooling tower.
 6. Measure cooling tower pump discharge pressure.
 7. Adjust water level and feed rate of makeup-water system.

3.12 TEMPERATURE TESTING

- A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.13 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Verify free travel and proper operation of control devices such as damper and valve operators.
- F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.
- G. Confirm interaction of electrically operated switch transducers.

- H. Confirm interaction of interlock and lockout systems.
- I. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.
- J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.14 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.
 - 3. Heating-Water Flow Rate: 0 to minus 10 percent.
 - 4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.15 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.16 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed by the certified testing and balancing agent.
 - 1. Include a list of the instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to the certified field report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

- D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
1. Title page.
 2. Name and address of testing, adjusting, and balancing Agent.
 3. Project name.
 4. Project location.
 5. Engineer's name and address.
 6. Contractor's name and address.
 7. Report date.
 8. Signature of testing, adjusting, and balancing Agent who certifies the report.
 9. Summary of contents, including the following:
 - a. Design versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 10. Nomenclature sheets for each item of equipment.
 11. Data for terminal units, including manufacturer, type size, and fittings.
 12. Notes to explain why certain final data in the body of reports vary from design values.
 13. Test conditions for fans and pump performance forms, including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
- F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches (mm), and bore.

- i. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
 - 2. Motor Data: Include the following:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
 - 3. Test Data: Include design and actual values for the following:
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Preheat coil static-pressure differential in inches wg (Pa).
 - g. Cooling coil static-pressure differential in inches wg (Pa).
 - h. Heating coil static-pressure differential in inches wg (Pa).
 - i. Outside airflow in cfm (L/s).
 - j. Return airflow in cfm (L/s).
 - k. Outside-air damper position.
 - l. Return-air damper position.
- G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data: Include the following:
 - a. System and air-handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F (deg C).
 - d. Duct static pressure in inches wg (Pa).
 - e. Duct size in inches (mm).
 - f. Duct area in sq. ft. (sq. m).
 - g. Design airflow rate in cfm (L/s).
 - h. Design velocity in fpm (m/s).
 - i. Actual airflow rate in cfm (L/s).
 - j. Actual average velocity in fpm (m/s).
 - k. Barometric pressure in psig (Pa).
- H. Cooling Tower Test Report: For cooling towers, include the following:
 - 1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Make and type.
 - c. Model and serial numbers.
 - d. Nominal cooling capacity in tons (kW).
 - e. Water-treatment chemical feeder and chemical.
 - f. Number and type of fans.
 - g. Fan motor make, frame size, rpm, and horsepower.

- h. Fan motor voltage at each connection.
 - i. Sheave make, size in inches (mm), and bore.
 - j. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
 - k. Number of belts, make, and size.
 - 2. Pump Test Data: Include design and actual values for the following:
 - a. Make and model number.
 - b. Manufacturer's serial number.
 - c. Motor make and frame size.
 - d. Motor horsepower and rpm.
 - e. Voltage at each connection.
 - f. Amperage for each phase.
 - g. Water flow rate in gpm (L/s).
 - 3. Water Test Data: Include design and actual values for the following:
 - a. Entering-water temperature in deg F (deg C).
 - b. Leaving-water temperature in deg F (deg C).
 - c. Water temperature differential in deg F (deg C).
 - d. Entering-water pressure in feet of head or psig (kPa).
 - e. Leaving-water pressure in feet of head or psig (kPa).
 - f. Water pressure differential in feet of head or psig (kPa).
 - g. Water flow rate in gpm (L/s).
 - h. Bleed water flow rate in gpm (L/s).
 - 4. Air Data: Include design and actual values for the following:
 - a. Duct airflow rate in cfm (L/s).
 - b. Inlet-duct static pressure in inches wg (Pa).
 - c. Outlet-duct static pressure in inches wg (Pa).
 - d. Average entering-air, wet-bulb temperature in deg F (deg C).
 - e. Average leaving-air, wet-bulb temperature in deg F (deg C).
 - f. Ambient wet-bulb temperature in deg F (deg C).
- I. Pump Test Reports: For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.
- 1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm (L/s).
 - g. Water pressure differential in feet of head or psig (kPa).
 - h. Required net positive suction head in feet of head or psig (kPa).
 - i. Pump rpm.
 - j. Impeller diameter in inches (mm).
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data: Include design and actual values for the following:

- a. Static head in feet of head or psig (kPa).
- b. Pump shutoff pressure in feet of head or psig (kPa).
- c. Actual impeller size in inches (mm).
- d. Full-open flow rate in gpm (L/s).
- e. Full-open pressure in feet of head or psig (kPa).
- f. Final discharge pressure in feet of head or psig (kPa).
- g. Final suction pressure in feet of head or psig (kPa).
- h. Final total pressure in feet of head or psig (kPa).
- i. Final water flow rate in gpm (L/s).
- j. Voltage at each connection.
- k. Amperage for each phase.

J. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.17 ADDITIONAL TESTS

- A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

3.18 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.19 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.20 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 05 94

PIPE PRESSURE TESTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe pressure tests for building services piping systems as scheduled in Part 3 of this section.

1.2 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. In addition to those submittals identified in the General Conditions, the following items shall also be submitted:
- C. Test Reports
 - 1. A separate test report shall be submitted for each pressure test performed.
 - 2. Information presented in test reports shall be typewritten, clear, concise, and accurate.
 - 3. Reports shall be signed and dated by the supervisor in charge of performing the test and designated Inspector. Signatures shall certify that all information contained in the report is true and accurate to the best of the signatory's knowledge.
 - 4. Reports shall contain, as a minimum, the following information:
 - a. Type of test performed (e.g., hydrostatic, pneumatic, refrigerant, etc.)
 - b. Description of system or portion of system to which testing was performed.
 - c. Date of test.
 - d. Time of pressure start.
 - e. Time of pressure test completion.
 - f. Test fluid used in test (e.g., tap water, dry air, refrigerant, etc).
 - g. Pressure reading at beginning of test.
 - h. Pressure reading at end of test.
 - i. Location of pressure indicating devices.
 - j. Precise location of leaks detected.
 - k. Summary of leaks detected and suggested corrective action.
 - l. Conclusions regarding overall fitness and condition of tested system.
 - m. Signatures as described above.
 - n. Appendix: Calibration history of instruments used.

1.3 QUALITY ASSURANCE

- A. Tester's Qualifications
 - 1. Workers and their supervisors performing the Work of this section shall be personally experienced in testing of pipe systems and shall have been regularly employed by a company with three years minimum experience in testing of similar pipe systems.

B. Inspection

1. Tests shall be performed by the Contractor in the presence of designated Inspector(s). Witness and signoff is required.
2. Inspectors shall, at all times, have access to any place where work is in preparation or in progress and Contractor shall provide sufficient safe and proper facilities for such access and inspection.

1.4 SCHEDULING AND SEQUENCING

- A. Perform test operations on complete piping system or in sections as required and/or directed to progress Work in satisfactory manner and not delay the general construction of the project.
- B. If testing is performed in sections, valve or cap-off sections of piping to be tested, utilizing valves to be installed in permanent piping systems or temporary valves or caps as required to perform tests.
- C. Transmit written notification of proposed date and time of pressure tests to the Owner's Representative at least 5 days in advance of such tests.
- D. Pressure tests shall be performed prior to the installation of piping insulation or coverings.
- E. Pressure tests on underground piping shall be performed when piping has been partially backfilled with joints exposed.
- F. Pressure tests shall be performed prior to initial operation of piping systems.

PART 2 - PRODUCTS

2.1 TEST MATERIALS

- A. Test Fluid: Where scheduled, test media shall meet the following criteria.
 1. Tap Water: Untreated well water or plant water.
 2. Drinking Water: Treated, chlorinated potable water.
 3. Air: Filtered, oil-free, dry compressed air supplied at or above indicated test pressure.

2.2 TEST EQUIPMENT

- A. Gauges: Calibrated, dial-type, suitable for use with specified test fluid. Upper limit of gauge pressure range shall be 1.33 times the specified test pressure. Gauge accuracy shall be 1 percent of the indicated reading or better.
- B. Soap Solution: American Gas & Chemical, "Leak-Tec"; or equivalent.
- C. Air Compressor: Unit rated to supply compressed air at or above required test pressure. Unit shall have necessary filters and driers to deliver clean, oil-free, dry compressed air. Unit shall have shut-off valve installed on discharge connection.
- D. Pressure Relief Valve: Suitable for use with compressed air, set to relieve at 10 to 15 percent above designated test pressure.

PART 3 - EXECUTION

3.1 GENERAL

- A. Tests shall be conducted at ambient temperature, unless otherwise specified.
- B. Do not use permanent system pressure gauges for pressure testing; remove and plug or isolate such gauges from the system during pressure tests.
- C. Instrumentation in, or attached to, the piping being tested shall be protected during testing by isolation or removal. Return instrumentation to pre-test condition after completion of pressure testing.
- D. Piping connected to specialties or equipment with a lower pressure rating than the specified test pressure shall be disconnected from the equipment (after the isolation valve) and openings plugged during the pressure test. After the completion of pressure testing, the piping shall be reconnected to the equipment.
- E. Expansion joints shall be provided with temporary restraint or blocked off during testing.
- F. Pressurization of piping systems by liquids or gases shall be executed in a slow and prudent manner to maintain safety, avoid over-pressurization, and avoid excessive leakage.
- G. Piping systems designed for gases that are tested with a liquid may require additional temporary support during tests to support the weight of the liquid. Provide extra support as required.
- H. If the piping fails the test requirements, the Contractor shall determine the cause of leakage, make necessary repairs, and retest the piping. This procedure shall be repeated until the piping complies with test requirements. A separate test report shall be submitted for each test to a piping system or section of piping.
- I. No caulking or putty shall be used in the repair of leaks. Back welding of threaded joints shall not be permitted as a means of repairing leaks.
- J. Test reports shall be filled out and readings recorded as testing proceeds.
- K. Safety glasses and hard hats shall be worn by personnel involved in or witnessing tests conducted at pressure of 20 psig or greater.

3.2 EXAMINATION

- A. Examine equipment and construction in the area of piping to be tested. Note equipment and existing construction that may be damaged by leakage of the test fluid.
- B. Verify that piping system bracing, alignment harnesses, and thrust restraints are in place before pressure is applied. Concrete restraints shall have cured adequately to withstand test pressure.
- C. Proceed with testing only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

- A. Protect equipment and construction which may be damaged by leakage of test fluid by covering with appropriate material or removing from area.
- B. Verify that piping to be tested is clean and all outlets in the system are closed.
- C. Open non-outlet valves in piping section to be tested. Check valves that can prevent system sections from being filled or pressurized shall have their discs, etc. removed for testing (restore check valves to their pre-test) condition after completion of pressure testing).
- D. Evacuate test areas of personnel not involved in the pressure testing.

3.4 HYDROSTATIC PRESSURE TEST

- A. Install pressure gauge to measure system pressure at low point in system.
- B. Connect pressurization pump to system.
- C. Fill the system with test liquid, opening vents to permit complete filling. Close vents.
- D. Using the pump, raise the pressure in the system to the scheduled test pressure. Hold pressure for a minimum of 1 hour.
- E. Reduce and hold the pressure 20 percent below test pressure. Inspect the entire system for visible leaks. Note location of leaks for repair.
- F. If leaks or defects are found, release the pressure, drain the system, and make repairs. Repair the test procedure on the repaired piping.
- G. If the piping shows no visible leakage, raise the pressure in the system to the scheduled test pressure and isolate the system, under pressure, from the pump. The system should be closed with the pressure gauge indicating test pressure within system.
- H. System shall remain pressurized for the duration indicated in the test schedule. After the specified duration, check pressure reading on system gauge. No detectable drop in pressure shall have occurred in the system.
- I. If a drop in pressure occurs, Contractor shall determine cause. Once cause is determined release the pressure, drain the system, repair pipe as necessary, and retest.
- J. Upon compliance with test requirements, drain the system, remove items added or replace those removed for testing.

3.5 PNEUMATIC PRESSURE TEST

- A. UNDER NO CIRCUMSTANCES SHALL PNEUMATIC TESTING BE PERFORMED ON NON-METALLIC PIPE.
- B. Install pressure gauge to measure system pressure.

- C. Connect air supply to piping system.
- D. Open inlet valve and allow pressure to increase slowly to 25 psig or 20 percent of scheduled test pressure, whichever is LESS.
- E. Close inlet valve and monitor system pressure for the duration indicated in the test schedule. Checking for any drop in pressure that would indicate leaks.
- F. If leaks are detected, locate leaks and judge the safety of bringing the system to the full test pressure. If judged unsafe, relieve the pressure on the system, repair leaks, and retest system at low pressure before proceeding.
- G. Increase pressure to the specified test pressure. Close inlet valve and monitor system pressure for duration specified in schedule. After the specified duration, check pressure reading on system gauge. No detectable drop in pressure shall have occurred in the system.
- H. If a drop in pressure occurs, Contractor shall check all joints and other possible sources of leaks with soap solution. Once cause is determined release the pressure, repair pipe as necessary, and retest.
- I. Upon compliance with test requirements, vent and allow system to return to atmospheric pressure. Remove items added or replace those removed for testing.

3.6 PIPE TEST SCHEDULE

- A. Perform pressure tests, of type indicated, on piping system(s) indicated using scheduled test fluid and pressure.
- B. Schedule

<u>Utility</u>	<u>Test Method</u>	<u>Test Medium</u>	<u>Test Pressure</u>	<u>Test Duration</u>	<u>Allowable Leakage</u>
Natural Gas	Pneumatic	Air*	50 psig	2 Hours	0
Digester Gas	Pneumatic	Air*	50 psig	2 Hours	0
Hydronic Piping	Hydrostatic	Water	100 psig	1 Hour	0

* - test medium may be air, nitrogen, or carbon dioxide.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes mechanical insulation as shown on the Contract Drawings.
 - 1. Semi-rigid and flexible duct and plenum; insulating cements; factory- or field-applied jackets; accessories and attachments; and sealing compounds.
 - 2. Blanket and board; insulating cements; factory- or field-applied jackets; accessories and attachments; and sealing compounds.

1.3 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. Military Specifications (MIL), as applicably noted.
 - 3. International Energy Conservation Code.

1.4 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Coordinate clearance requirements with duct, equipment and piping Installer(s) for insulation applications.
- C. Coordinate size and location of supports, hangers, and insulation shields specified in the Section "Hangers and Supports for HVAC Piping and Equipment."
- D. Coordinate installation and testing of electric heat tracing.

1.5 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- C. Shop Drawings:
 - 1. Show fabrication and installation details for the following:
 - a. Duct

- 1) Removable insulation sections at access panels.
- 2) Application of field-applied jackets.
- 3) Applications at linkages for control devices.
- 4) Duct lining.

D. Certificates:

1. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.6 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.7 SCHEDULING

- A. Schedule insulation application after testing duct systems and piping systems. Insulation application may begin on segments of piping and ducts that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mineral-Fiber Insulation:
 - a. CertainTeed Manson.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.
 - d. Johns Manville Corp.
 - e. Or approved equal.
2. Flexible Elastomeric Thermal Insulation:
 - a. Armstrong World Industries, Inc.
 - b. Rubatex Corp.

- c. Aerocel
- d. Or approved equal.
- 3. Closed-Cell Phenolic-Foam Insulation:
 - a. Kooltherm Insulation Products, Ltd.
 - b. Kingspan Corp
 - Or approved equal.

2.2 INSULATION MATERIALS

A. Duct / Equipment

- 1. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film. Jacket to have self-sealing lap as applicable for application.
- 2. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.
 - a. Adhesive: As recommended by insulation material manufacturer.
 - b. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
- 3. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
 - a. Adhesive: As recommended by insulation material manufacturer.
 - b. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

B. Piping/Equipment

- 1. Closed-Cell Phenolic-Foam Insulation: Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1 reformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
- 2. Install piping insulation in accordance with manufacturer's instructions.
- 3. Install field-applied jacket for above grade.

2.3 FIELD-APPLIED JACKETS

A. Duct / Equipment

- 1. General: ASTM C 921, Type 1, unless otherwise indicated.
- 2. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- 3. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
 - a. Adhesive: As recommended by insulation material manufacturer.
 - b. PVC Jacket Color: White.

B. Piping

- 1. PVC Jacket: PVC jacket shall be ProtoCorp or equal, and shall match existing PVC jacketing in plant.

- a. PVC jacket for straight pipe, manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC for indoor use only.
- b. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC for indoor use only. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, traps, grooved pipe joints, grooved pipe fittings.
- c. Adhesive: As recommended by insulation and/or material manufacturer for temperature application.

2.4 ACCESSORIES AND ATTACHMENTS

A. General

1. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz/yd².
 - a. Tape Width: 4 inches.
2. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
 - a. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
 - b. Galvanized Steel: 0.005 inch thick.
 - c. Aluminum: 0.007 inch thick.
 - d. Brass: 0.010 inch thick.
 - e. Nickel-Copper Alloy: 0.005 inch thick.
3. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

B. Duct / Equipment

1. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.
 - a. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.
2. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
 - a. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.
3. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

2.5 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with temperature range, insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- D. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- E. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- F. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of equipment, ducts/fittings and piping, including fittings, valves and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct, equipment and piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- F. Keep insulation materials dry during storage, application and finishing.

- G. Apply duct, equipment and pipe insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Apply insulation with the least number of joints practical.
- I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 1. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- L. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
 - 3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.
 - 4. Circumferential Joints: Cover with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 - 5. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
- M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

- N. Install vapor-retarder mastic on equipment, ducts and plenums scheduled to receive vapor retarders.
 - 1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
 - 2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.
 - 3. Equipment with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
- O. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - 1. Seal penetrations with vapor-retarder mastic.
 - 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - 3. Seal insulation to roof flashing with vapor-retarder mastic.
 - 4. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
- P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- Q. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.
- R. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.
 - 1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.
- S. Insulate the following indoor equipment:
 - 1. Heating hot-water air separators.
- T. Omit equipment insulation from the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 MINERAL-FIBER INSULATION APPLICATION: DUCTWORK

- A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 - c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 4. Impale insulation over anchors and attach speed washers.
 5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
 7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
 8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
 10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.
- B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Space anchor pins as follows:
 - a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.

- c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
- d. Do not overcompress insulation during installation.
- 4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
- 6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
- 8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION: DUCTWORK

- A. Apply insulation to ducts and plenums as follows:
 - 1. Follow the manufacturer's written instructions for applying insulation.
 - 2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the duct and plenum surface.

3.6 FIELD-APPLIED JACKET APPLICATION: DUCTWORK

- A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
 - 1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch-thick coats of jacket manufacturer's recommended adhesive.
 - 3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

3.7 FINISHES: DUCTWORK – EXPOSED

- A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Section "Painting."
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.8 DUCT SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in Table 1 at the end of this Section.

- B. Materials and thicknesses for systems listed below are specified in Table 1 at the end of this Section.
- C. Insulate the following plenums and duct systems:
 - 1. Gas unit heater combustion air ductwork.
 - 2. Gas unit heater gas-vent pipes within 8 ft above finished floor.
- D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner.
 - 3. Flexible connectors.
 - 4. Vibration-control devices.
 - 5. Testing agency labels and stamps.
 - 6. Nameplates and data plates.
 - 7. Access panels and doors in air-distribution systems.

3.9 FINISHES: EQUIPMENT

- A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 9 Section "Painting."
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.10 EQUIPMENT APPLICATIONS

- A. Insulation materials and thicknesses are specified in Table 2 at the end of this Section.

3.11 INSTALLATION

- A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

TABLE 1 – DUCT INSULATION MATERIALS

Notes indicated in () are at end of Table 1

SERVICE	INSULATION MATERIAL	THICKNESS	NOTES
Air conditioning supply	Exposed: Rigid mineral fiber Concealed: Flexible mineral fiber	1 inch	Maintain vapor retarder. Exposed ductwork in public areas shall be lined.
Air conditioning return	Exposed: Rigid mineral fiber Concealed: Flexible mineral fiber	1 inch	(1)
Outdoor air ducts and plenums, connections, and mixing boxes installed indoors	Rigid mineral fiber	2 inches	Provide neat fit at intake plenum Maintain vapor retarder.

TABLE 1 – DUCT INSULATION MATERIALS

Notes indicated in () are at end of Table 1

SERVICE	INSULATION MATERIAL	THICKNESS	NOTES
Ducts located outdoors and weatherproofed	Flexible Elastomeric foam	2 inches	(2)
Boiler combustion air	Preformed mineral fiber	2 inches	Maintain vapor barrier
.			
Note 1: Return air ducts within air conditioned spaces, or above lay-in ceilings of air conditioned spaces, or in return air plenums are not to be insulated. Note 2: Fasten mechanically and with recommended adhesive. Make watertight and airtight, cover seams and joints and 100% of duct. Finish weatherproof with aluminum jacket or two 1/8-inch coats of “Miracle” CO-130 mastic, as made by Miracle Adhesive Corp., troweled smooth with a layer of “Duramesh” glass fabric between coatings.			

TABLE 2 – EQUIPMENT INSULATION MATERIALS

Not used.

TABLE 3 – PIPE INSULATION MATERIALS

Notes indicated in () are at end of Table 3

SERVICE	INSULATION MATERIAL	THICKNESS	NOTES
Heating Hot Water Supply and Return: 1.5” diameter and smaller	Mineral Fiber Pipe Insulation with white PVC Jacket	1.5 inch	
Heating Hot Water Supply and Return: larger than 1.5” diameter	Mineral Fiber Pipe Insulation with white PVC Jacket	2 inch	
Refrigerant	Flexible Elastomeric Pipe Insulation with white PVC Jacket	1.5 inch	Maintain vapor barrier

3.12 PAINTING

- A. Perform field painting in accordance with the Section “Painting”.
- B. Do not paint PVC jacketing.

3.13 IDENTIFICATION

- A. Identify as specified in Section “Identification for HVAC Piping and Equipment”.

3.14 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior “white glove clean”, removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.15 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Instrumentation devices for HVAC
 - 2. Control devices for HVAC (including pneumatic devices)
- B. Coordinate Work of this Section with Electrical Work.

1.2 COORDINATION REQUIREMENTS

- A. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor-Control Centers," "Panelboards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.
- C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.
- D. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. In addition to those submittals identified in the General Conditions, the following items shall also be submitted:
 - 1. Manufacturer's certification that all materials furnished are in compliance with the applicable requirements of the referenced Standards and this specification.
- C. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
 - 1. Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - a. Each control device labeled with setting or adjustable range of control.

D. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - a. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - b. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - c. Written description of sequence of operation.

PART 2 - PRODUCTS

2.1 ELECTRIC CONTROL DEVICES

- A. Thermostat: Industrial-duty, line-voltage, on-off temperature controller. Thermostat shall be bimetal-actuated, open contact; or bellows-actuated, enclosed, snap-switch type; or equivalent solid-state type. Set point range shall be 36-100°F. Switching shall be SPDT and shall be rated for the connected load. Controller shall be model T4054 as manufactured by Honeywell, or approved equal.
- B. Explosion-Proof Thermostat: Heavy-duty line voltage thermostat. Unit shall be suitable for Class I, Division 1 or 2, Group D location. Set point range shall be 46-84°F. Switching shall be SPDT and shall be rated for the connected load. Thermostat shall be model T6051B1006 as manufactured by Honeywell, or approved equal.
- C. Remote-Bulb Thermostat: Line-voltage, on-off temperature controller. Thermostat shall be bimetal-actuated, open contact; or bellows-actuated, enclosed, snap-switch type; or equivalent solid-state type. Thermostat shall have adjustable differential, 5 ft capillary, copper sensing bulb, and sensing bulb holder. Set point range shall be 0-100°F. Differential range shall be 3-10°F. Switching shall be SPDT and shall be rated for the connected load. Sensing bulbs mounted outdoors shall be provided with shields. Controller shall be model T675A1508 as manufactured by Honeywell, or approved equal.
- D. Room thermostat accessories include the following:
 1. Insulating Bases: For thermostats located on exterior walls.
- E. Freezestat (Low-Limit Temperature Controller): Snap-acting, single-pole, single-throw, manual- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 1. Bulb Length: Minimum 20 feet.
 2. Quantity: Two freezestats for each coil (for redundancy). One freezestat for every 20 sq ft of coil surface.
 3. Temperature setpoint range: 20 to 60F. Set to 35F unless otherwise noted.
 4. Honeywell Model L480G or approved equal.
- F. Electronic Damper and Valve Actuators: Direct-coupled type designed for minimum 100,000 full-stroke cycles at rated torque. Belimo or equal.
 1. Valves: Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).

2. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lbs/sq ft of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lbs/sq ft of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lbs/sq ft damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lbs/sq ft of damper.
 - e. Dampers with 2 to 3 inches wg of Pressure Drop or Face Velocities of 1000 to 2500 FPM: Multiply the minimum full-stroke cycles above by 1.5.
 3. Coupling: V-bolt and V-shaped, toothed cradle.
 4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
 6. Power Requirements (Two-Position Spring Return): 120V ac.
 7. Power Requirements (Modulating): Maximum 15 VA at 24-V ac.
 8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 9. Temperature Rating: 22 deg F to 122°F.
 10. Run Time: 200 seconds open, 40 seconds closed.
- G. Smoke Detector: Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. Provide explosion-proof smoke detectors in classified areas. Explosion proof units shall be suitable for Class I, Division 1, Group D classified areas.
- H. Air Flow Switch:
1. Differential pressure switch shall be suitable for measuring differential pressure between points in a duct system (e.g. upstream and downstream of a fan) and shall have a nominal pressure sensing range of 0.15 to 0.5 inches (water gauge pressure).
 2. Units shall be provided with one pair of normally open contacts which shall close whenever the sensed differential pressure drops below 0.1 inch.
 3. Units shall be provided with explosion-proof housing rated for NEC Class I, Division 1, Group D areas. Units shall be suitable for operating down to -20 degrees F.
 4. Units shall be suitable for operating down to -20 degrees Fahrenheit.
 5. Pressure switches shall be provided with pressure gauge and wall mounting plate.
 6. Provide with permanently-mounted duct velocity sensing (pitot) probe and interconnecting tubing. Mount probe in fan discharge duct.
 7. Dwyer Series 1950 or approved equal.
- I. Magnehelic Differential Pressure Gauge: Die cast aluminum case and bezel, with acrylic cover. Provide 4" diameter face and 0 to 0.25" water column gauge range. Provide with enclosure and accessories for surface mounting. Provide with sensing tubes. Dwyer 2000 or approved equal.
- J. Hot Water Temperature Controller: Stand-alone controller accepting input from temperature sensor and providing modulating output for positioning temperature control valve. Unit shall provide control algorithm to maintain sensed hot water temperature at setpoint. Honeywell T775 2000 Series or approved equal. Provide with immersion sensor and well

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.
- B. Verify that duct-, pipe-, and equipment-mounted devices and wiring are installed before proceeding with installation.
- C. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- D. Examine roughing-in of Instrumentation and Control Devices for HVAC systems to verify the following:
 - 1. Instrumentation and Control Devices for HVAC systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- E. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- F. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install equipment level and plumb.
- B. Verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate all 60 inches above the floor.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- C. Install damper actuators on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- D. Install smoke detectors in accordance with NFPA 72.
- E. Install labels and nameplates to identify control components according to the Section "Identification for HVAC Piping and Equipment."
- F. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.3 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.4 IDENTIFICATION

- A. Identify as specified in the Section “Identification of HVAC piping and Equipment.”

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior “white glove clean”, removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.6 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Direct-digital control (DDC) systems for two locations:
 - 1. Administration Building – control for Building HVAC.
 - 2. Solids Handling Building Boiler Room – control for boiler systems and supporting combustion air supply and temperature control.
- B. General: The control system shall consist of two independent controllers provided with the future capability to integrate into a BACnet protocol, high-speed, peer-to-peer network of DDC controllers with an operator workstation. Each independent controller shall be as defined in this specification. Each controller shall contain an operator user interface. The operator user interface shall provide for overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation as defined in 'System Performance', and 'Controllers' subsections.
- C. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. I/O points, schedules, setpoints, trends and alarms specified in 23 09 93 – "Sequence of Operations for HVAC Controls" shall be BACnet objects.

1.2 APPROVED CONTROL SYSTEM MANUFACTURERS

- A. The following are approved control system manufacturers:
 - 1. Siemens
 - 2. Or Approved Equal
- B. The above list does not indicate order of preference. Inclusion on this list does not guarantee acceptance of products or installation. Control systems shall comply with the terms of this specification.
- C. The Contractor shall use only operator workstation software, controller software, custom application programming language, and controllers from the corresponding manufacturer and product line unless Owner approves use of multiple manufacturers.
- D. Other products specified herein (such as sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

1.3 QUALITY ASSURANCE

- A. Installer and Manufacturer Qualifications

1. Installer shall have an established working relationship with Control System Manufacturer.
2. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

1.4 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to the receipt of bids of the following codes:
 1. National Electric Code (NEC)
 2. International Building Code (IBC)
 - a. Section 719 Ducts and Air Transfer Openings
 - b. Section 907 Fire Alarm and Detection Systems
 - c. Section 909 Smoke Control Systems
 - d. Chapter 28 Mechanical
 3. International Mechanical Code (IMC)
 4. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Systems

1.5 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).
 1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
 2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
 3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
 4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
 5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 sec.
 6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
 7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
 8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.
 9. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.

10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

Table-1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C (±1°F)
Ducted Air	±0.5°C (±1°F)
Outside Air	±1.0°C (±2°F)
Dew Point	±1.5°C (±3°F)
Water Temperature	±0.5°C (±1°F)
Delta-T	±0.15° (±0.25°F)
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Electrical	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO2)	±50 ppm

Note 1: Accuracy applies to 10%–100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

Table 2
Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0–1.5 kPa (0–6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±3°F)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1–150 psi) 0–12.5 kPa (0–50 in. w.g.)

1.6 SUBMITTALS

- A. Product Data and Shop Drawings: Meet requirements of Section 01 30 00 on Shop Drawings, Product Data, and Samples. In addition, the contractor shall provide shop drawings or other submittals on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2006 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or

comparable) and three 11" x 17" prints of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Submittals shall be provided within 12 weeks of contract award. Submittals shall include:

1. DDC System Hardware
 - a. A complete bill of materials to be used indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
 - b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
 - 1) Direct digital controllers (controller panels)
 - 2) Transducers and transmitters
 - 3) Sensors (including accuracy data)
 - 4) Actuators
 - 5) Valves
 - 6) Relays and switches
 - 7) Control panels
 - 8) Power supplies
 - 9) Batteries
 - 10) Operator interface equipment
 - 11) Wiring
 - c. Wiring diagrams and layouts for each control panel. Show termination numbers.
 - d. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Central System Hardware and Software
 - a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and relevant technical.
 - b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
 - 1) Central Processing Unit (CPU) or web server
 - 2) Monitors
 - 3) Keyboards
 - 4) Power supplies
 - 5) Battery backups
 - 6) Interface equipment between CPU or server and control panels
 - 7) Operating System software
 - 8) Operator interface software
 - 9) Color graphic software
 - 10) Third-party software
 - c. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all

- cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
- d. Network riser diagrams of wiring between central control unit and control panels.
3. Controlled Systems
 - a. Riser diagrams showing control network layout, communication protocol, and wire types.
 - b. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - c. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - d. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - e. A mounting, wiring, and routing plan-view drawing. The design shall take into account HVAC, electrical, and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
 - f. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - g. A point list for each control system. List I/O points and software points specified in Section 23 09 93. Indicate alarmed and trended points.
 4. Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.
 5. Description of process, report formats, and checklists to be used in Section 23 09 23 Article 3.17 (Control System Demonstration and Acceptance).
 6. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

B. Schedules

1. Within one month of contract award, provide a schedule of the work indicating the following:
 - a. Intended sequence of work items
 - b. Start date of each work item
 - c. Duration of each work item
 - d. Planned delivery dates for ordered material and equipment and expected lead times
 - e. Milestones indicating possible restraints on work by other trades or situations
2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

C. Project Record Documents. Upon completion of installation, submit three copies of record (as-built) documents of the documents shall be submitted for approval prior to final completion and shall include:

1. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD 2006 (or newer) compatible files on magnetic or optical media (file format: .DWG, .DXF, .VSD, or comparable) and as 11" x 17" prints.
 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 23 09 23 Article 3.17 (Control System Demonstration and Acceptance).
 3. Operation and Maintenance (O&M) Manual.
 4. As-built versions of submittal product data.
 5. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 6. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 7. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 8. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 9. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
 10. Graphic files, programs, and database on magnetic or optical media.
 11. List of recommended spare parts with part numbers and suppliers.
 12. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 13. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 14. Licenses, guarantees, and warranty documents for equipment and systems.
 15. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- D. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class.

1.7 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
1. Graphics
 2. Record drawings

3. Database
4. Application programming code
5. Documentation
6. USB connecting cable to laptop

1.8 DEFINITIONS

Term	Definition
BACnet Interoperability Building Blocks (BIBB)	A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification.
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token Passing	Data link protocol as defined by the BACnet standard.
Point-to-Point	Serial communication as defined in the BACnet standard.
Primary Controlling LAN	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
Protocol Implementation Conformance Statement	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Router	A device that connects two or more networks at the network layer.
Wiring	Raceway, fittings, wire, boxes and related items.

1.9 GLOSSARY OF TERMS

- A. Advanced Application Controller (AAC): A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read and write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet.
- B. Application Specific Controller (ASC): A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can choose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil

units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.

- C. BACnet/IP: An approved BACnet network type which uses an Ethernet carrier and IP addressing.
- D. BACnet MS/TP: An approved BACnet network type which uses a Master-Slave Token Passing configuration. MS/TP networks are unique to BACnet and utilize EIA485 twisted pair topology running at 9600 to 76,800 bps.
- E. BACnet over ARCNET: An approved BACnet network type which uses an ARCNET (attached resource computer network) carrier. ARCNET is an industry standard that can utilize several speeds and wiring standards. The most common configuration used by BACnet controllers is an EIA485 twisted pair topology running at 156,000 bps.
- F. Building Controller (BC): A fully programmable control module which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically this controller is located on the Ethernet/IP backbone of the BAS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.
- G. Direct Digital Control (DDC): A control system in which a digital computer or microprocessor is directly connected to the valves, dampers, and other actuators which control the system, as opposed to indirectly controlling a system by resetting setpoints on an analog pneumatic or electronic controller.
- H. PICS - Protocol Implementation Conformance Statement: A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.
- I. Smart Actuator (SA): An actuator which is controlled by a network connection rather than a binary or analog signal. (0-10v, 4-20mA, relay, etc.).
- J. Smart Sensor (SS): A sensor which provides information to the BAS via network connection rather than a binary or analog signal. (0-10000 ohm, 4-20mA, dry contact, etc.).
- K. Web services: Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system.

1.10 ABBREVIATIONS

- A. The following abbreviations may be used in graphics, schematics, point names, and other UI applications where space is at a premium.

AC - Air Conditioning	HWR - Hot Water Return
ACU - Air Conditioning Unit	HWS - Hot Water Supply
AHU - Air Handling Unit	MAX - Maximum
AI - Analog Input	MIN - Minimum
AO - Analog Output	MISC - Miscellaneous
AUTO - Automatic	NC - Normally Closed
AUX - Auxiliary	NO - Normally Open
BI - Binary Input	OA - Outdoor Air
BO - Binary Output	PIU - Powered Induction Unit
C - Common	RA - Return Air
COND - Condenser	RF - Return Fan
CW - Condenser Water	RH - Relative Humidity
DA - Discharge Air	RTU - Roof-top Unit
EA - Exhaust Air	SA - Supply Air
EF - Exhaust Fan	SF - Supply Fan
EVAP - Evaporators	SP - Static Pressure
FCU - Fan Coil Unit	TEMP - Temperature
HOA - Hand / Off / Auto	UH - Unit Heater
HP - Heat Pump	UV - Unit Ventilator
HW - Hot Water	VAV - Variable Air Volume
HWP - Hot Water Pump	

PART 2 - PRODUCTS

2.1 GENERAL

- A. Panels shall be a minimum of NEMA 12.
- B. Equipment and devices installed in hazardous areas shall be rated for the application (Class I, Division 1 or 2, Group D). Refer to electrical drawings for hazard classifications.

2.2 MATERIALS

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.3 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.

- B. Install new wiring and network devices as required to provide a complete and workable control network.
- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 23 09 93. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Workstations, Building Control Panels, and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.
- F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.
- G. The DDC system shall interface with controllers provided with each piece of equipment connected to the system. The DDC system shall provide full function of all inputs and outputs available with each piece of equipment. The DDC supplier shall coordinate with the equipment suppliers to optimize communications, control, and operator interface with equipment through the DDC system. Equipment shall include:
 - 1. Administration Building Boiler
 - 2. Administration Building Air Handling Unit
 - 3. VAV Terminal Units (quantity 8)
 - 4. Administration Building Rooftop Unit
 - 5. Solids Handling Building Boilers (quantity 5)
 - 6. Solids Handling Building Make-up Air Unit (combustion air)

2.4 OPERATOR INTERFACE

- A. Two PC-based Laptop Computer (Workstation) shall be provided for access to building controllers. Each Laptop Computer shall be able to access all system information, modify setpoints, and test configurations.

- B. The Workstation shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L.
- C. Communication. Laptop computer and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.
- D. Hardware. Each workstation shall consist of the following:
 - 1. Laptop Computer. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The following hardware requirements also apply:
 - a. The hard disk shall have sufficient memory to store:
 - 1) All required operator workstation software.
 - 2) A DDC database at least twice the size of the delivered system database.
 - 3) One year of trend data based on the points specified to be trended at their specified trend intervals.
 - b. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.
 - c. Minimum hardware configuration shall include the following:
 - 1) Laptop configuration.
 - 2) Dual or Quad Core Processor
 - 3) 6 GB RAM
 - 4) 500 GB hard disk providing data at 3.0 Gb/sec
 - 5) 16x DVD-RW drive
 - 6) Mouse
 - 7) 15-inch 24-bit color screen with at least 1024 x 768 resolution
 - 8) Serial, parallel, and network communication ports and cables as required for proper DDC system operation
- E. System Software.
 - 1. Operating System. Web server or workstation shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the DDC System manufacturer's minimum requirements for their software. Typically acceptable systems include Microsoft Windows7, Windows Server 2003 or 2008, Red Hat Enterprise Linux, or Ubuntu Desktop 10.04. Coordinate with Owner to identify requirements.
 - 2. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract.
 - a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.

- b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Adobe Flash).
 - 3. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in the same formats as are used for system graphics.
 - 4. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- F. System Applications. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
- 1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 - 2. Manual Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
 - 3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection. Operators shall be able to configure the system.
 - 4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
 - 5. Security. Each operator shall be required to log on to the system with user name and password in order to view, edit, add, or delete data.
 - a. Operator Access. The user name and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users.

- b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time shall be user adjustable.
 - c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
- 6. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
- 7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 23 09 93 (Sequences of Operation). Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
- 8. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms.
- 9. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
- 10. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard disk.
- 11. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 23 09 93 (Sequences of Operation). Trends shall be BACnet trend objects.
- 12. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
- 13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
- 14. Standard Reports. Furnish the following standard system reports:
 - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 - 1) Alarm History.
 - 2) Trend Data. Operator shall be able to select trends to be logged.

- 3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
- G. Workstation Application Editors. Each PC or browser workstation shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controller panels.
1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
 2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.
 3. Custom Application Programming. Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language. Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."
 - b. A full-screen character editor programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate features such as cut/ paste and find.
 - c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
 - d. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results.
 - e. The programming language shall support conditional statements (IF/THEN/ELSE/ ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - f. The programming language shall support floating-point arithmetic using the following operators: +, -, $\div$, $\times$, and square root. The following mathematical functions also shall be provided: absolute value and minimum/maximum value.
 - g. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the

language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/ THEN comparisons, calculations, etc.

- h. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.
 - i. The programming language shall have predefined variables representing the status and results of the system software and shall be able to enable, disable, and change the setpoints of the system software described below.
- H. Portable Operator's Terminal. Provide one laptop computer for WWTP operators. Provide all necessary software to configure IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

2.5 CONTROLLER SOFTWARE

- A. Furnish the following applications for building and energy management. All software application shall reside and operate in the system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. System Security. See Paragraph 2.3.E.5 (Security) and Paragraph 2.3.E.14.c.iii (Operator Activity).
- C. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
 - 1. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - 2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
 - 3. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period.
- D. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
- E. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.

- F. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.
- G. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.
- H. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
- I. Demand Limiting.
 - 1. The demand-limiting program shall monitor building power consumption from a building power meter (provided by others) which generates pulse signals or a BACnet communications interface. An acceptable alternative is for the system to monitor a watt transducer or current transformer attached to the building feeder lines.
 - 2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in Section 23 09 93 (Sequences of Operation). When demand drops below adjustable levels, system shall restore loads as specified.
- J. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in 23 09 93 (Sequences of Operation).
- K. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified in Section 23 09 93 (Sequences of Operation).
- L. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.
- M. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
- N. Energy Calculations.
 - 1. The system shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
 - 2. The system shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

- O. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- P. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.
- Q. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 23 09 93 (Sequence of Operations).

2.6 CONTROLLERS

- A. General. Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Section 23 09 23 Article 1.9 (System Performance). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.
- B. BACnet.
 - 1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
 - 2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
 - 3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
 - 4. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
 - 5. BACnet Communication.
 - a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
 - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall

reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

- d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

C. Communication

- 1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
- 2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
- 3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
- 4. Stand-Alone Operation. Each piece of equipment specified in Section 23 09 93 shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.

D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.

- 1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
- 2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

E. Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

F. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

G. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

- H. Memory.
1. Controller memory shall support operating system, database, and programming requirements.
 2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
 3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- J. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.
- K. Minimum controllers required:
1. Administration Building Controller (BC)- The Administration Building Controller shall be the (BC) controller for the following systems:
 - a. Variable Air Volume Air Handling Unit / Exhaust Fan Controller (AAC)
 - 1) This AAC shall be provided by the Variable Air Volume Air Handling Unit manufacturer.
 - 2) This AAC shall be capable of controlling the AHU, EF, and dampers and sensors as necessary to comply with the Sequence of Operations.
 - b. Boiler Controller (AAC)
 - 1) This controller shall
 - a) be provided by the Boiler manufacturer if available with BACNet Compatibility.
 - b) if not available through the manufacturer with BACnet compatibility, the controller shall be provided under this section as an AAC.
 - 2) This controller shall be capable of controlling:
 - a) Boiler
 - b) Combustion air dampers
 - c) Burner operation
 - d) Other devices required for complete boiler operation in accordance with manufacturer requirements.
 2. Existing Solids Handling Building Boiler Room Controller (BC) - The Existing Solids Handling Building Boiler Room Controller shall be the (BC) controller for the following systems:
 - a. Boiler Manager (AAC) -- The Boiler Manager AAC shall be provided by the manufacturer of the Boilers. The boiler manager shall control the following systems:
 - 1) Digester Heating System (ASC)
 - 2) Building Heating System (ASC)
 - 3) Combustion Air System (ASC)
 - 4) In addition, the boiler manager shall:
 - 5) -- provide a user interface,

- 6) --store data for up to 2 years including: heat input, heat loss, and net useful heat, fuel flow per hour and fuel flow totalized, flow metering
- 7) --be capable of controlling up to 10 systems, alter setpoints, enable, disable burner, re-order boiler sequencing and selection of lead boiler, remote load index control, select fuel type, provide flame safeguard functions, provide water level control functions, and have BACNet connectivity.
- b. Heat Dilution (ASC)
3. Controllers shall control each application as described in Section Sequence of Operation, and in accordance with manufacturer's requirements for operation.
4. If the manufacturer of an air handling unit or boiler cannot provide a BACNet protocol compatible controller, in each instance the contractor shall provide a controller, including programming and equipment as necessary for a fully functioning system.
5. DDC controllers can be consolidated where the contractor can provide equipment and documentation that the function and capabilities as required by this specification and 23 09 93 Sequence of Operations are satisfied and the following requirements are met:
 - a. Boiler manufacturer controls shall be used for control of boilers.
 - b. Air Handling Unit manufacturer controls shall be used for control of air handling units.
 - c. BACNet Protocol compliance is required and shall be documented by PICS.
 - d. The contractor shall note on the submittal that controllers are being consolidated.
 - e. At minimum one DDC controller with Ethernet connectivity shall be provided per building as follows:
 - 1) Administration building
 - 2) Existing Solids Handling building
 - 3) Secondary Gallery
 - 4) Fine Screen Building.

2.7 INPUT AND OUTPUT INTERFACE

- A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- B. Protection. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.
- C. Binary Inputs. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.

- E. Analog Inputs. Analog inputs shall monitor low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- I. System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system

2.8 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA listed.
- B. Power Line Filtering.
 - 1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less

- c. Transverse mode noise attenuation of 65 dB or greater
- d. Common mode noise attenuation of 150 dB or greater at 40–100 Hz

2.9 STATUS PANELS

- A. Provide status panel for each hot water system: digester heat system and building heat system.
- B. Panels shall have NEMA 12 enclosures.
- C. Each panel shall display:
 - 1. Hot water supply temperature (digital display)
 - 2. Status of each boiler: off, alarm, on (red, yellow, and green indicator lights)
 - 3. Status of each pump: off, alarm, on (red, yellow, and green indicator lights)
 - 4. System alarm status – trouble alarm and fault alarm (yellow and red indicator lights).

2.10 AUXILIARY CONTROL DEVICES

- A. Each device shall be rated for the environment in which it is located.
 - 1. Devices in electrically classified spaces shall be rated as required
 - a. In example, a Class I, Division I, Group D environment shall require NEMA 7 rated equipment.
 - 2. Devices in corrosive, wet environments that are not electrically classified shall be rated NEMA 4x.
 - 3. See the Electrical Drawings for electrical classification of specific areas.
- B. Motorized Control Dampers, unless otherwise specified elsewhere, shall be as follow.
 - 1. Type. Control dampers shall be the parallel or opposed-blade type as specified below or as scheduled on drawings.
 - a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
 - b. Other modulating dampers shall be opposed-blade.
 - c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
 - 2. Frame. Damper frames shall be 2.38 mm (13 gauge) galvanized steel channel or 3.175 mm (1/8 in.) extruded aluminum with reinforced corner bracing.
 - 3. Blades. Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades shall be suitable for medium velocity (10 m/s [2000 fpm]) performance. Blades shall be not less than 1.5875 mm (16 gauge).
 - 4. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
 - 5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 50 L/s·m²(10 cfm per ft²) at 1000 Pa (4 in. w.g.) differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 7.5 m/s (1500 fpm).

6. Sections. Individual damper sections shall not exceed 125 cm × 150 cm (48 in. × 60 in.). Each section shall have at least one damper actuator.
7. Modulating dampers shall provide a linear flow characteristic where possible.
8. Linkages. Dampers shall have exposed linkages.

C. Electric Damper and Valve Actuators.

1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
3. Signal and Range. Proportional actuators shall accept a 0–10 Vdc or a 0–20 mA control signal and shall have a 2–10 Vdc or 4–20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 2.6H.)
4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.

D. Control Valves.

1. Control valves shall be two-way or three-way type for two-position or modulating service as shown.
2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Water Valves:
 - 1) Two-way: 150% of total system (pump) head.
 - 2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - b. Steam Valves: 150% of operating (inlet) pressure.
3. Water Valves.
 - a. Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - b. Sizing Criteria:
 - 1) Two-position service: Line size.
 - 2) Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, whichever is greater.
 - 3) Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa (5 psi) maximum.
 - 4) Valves ½ in. through 2 in. shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.

- 5) Valves 2½ in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.
- c. Water valves shall fail normally open or closed, as scheduled on plans, or as follows:
 - 1) Water zone valves—normally open preferred.
 - 2) Heating coils in air handlers—normally open.
 - 3) Chilled water control valves—normally closed.
 - 4) Other applications—as scheduled or as required by sequences of operation.
- E. Binary Temperature Devices.
 1. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C–30°C (55°F–85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
 2. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C–30°C (55°F–85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
 3. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.
- F. Temperature Sensors.
 1. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
 2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m²(10 ft²) of duct cross-section.
 3. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
 4. Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.
 5. Differential Sensors. Provide matched sensors for differential temperature measurement.
- G. Humidity Sensors.
 1. Duct and room sensors shall have a sensing range of 20%–80%.
 2. Duct sensors shall have a sampling chamber.
 3. Outdoor air humidity sensors shall have a sensing range of 20%–95% RH and shall be suitable for ambient conditions of -40°C–75°C (-40°F–170°F).
 4. Humidity sensors shall not drift more than 1% of full scale annually.
- H. Flow Switches. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service) as shown. Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).

1. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
2. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

I. Relays.

1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm 100\%$ from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

J. Override Timers.

1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0–6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

K. Current Transmitters.

1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4–20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
3. Unit shall be split-core type for clamp-on installation on existing wiring.

L. Current Transformers.

1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
2. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

M. Voltage Transmitters.

1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4–20 mA output with zero and span adjustment.
2. Adjustable full-scale unit ranges shall be 100–130 Vac, 200–250 Vac, 250–330 Vac, and 400–600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

N. Voltage Transformers.

1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 4°C–55°C (40°F–130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic.

O. Power Monitors.

1. Selectable rate pulse output for kWh reading, 4–20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0–0.33 volt inputs.
2. 1.0% full-scale true RMS power accuracy, ± 0.5 Hz, voltage input range 120–600 V, and auto range select.
3. Under voltage/phase monitor circuitry.
4. NEMA 1 enclosure.
5. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0–0.33 V output. If 0–5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required.

P. Hydronic Flowmeters

1. Insertion-Type Turbine Meter
 - a. Dual counter-rotating axial turbine elements, each with its own rotational sensing system, and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Single turbine for piping 2 inches and smaller. Flow sensing turbine rotors shall be non-metallic and not impaired by magnetic drag.
 - b. Insertion type complete with ‘hot-tap’ isolation valves to enable sensor removal without water supply system shutdown.
 - c. Sensing method shall be impedance sensing (non magnetic and non photoelectric)
 - d. Volumetric accuracy
 - 1) $\pm 0.5\%$ of reading at calibrated velocity
 - 2) $\pm 1\%$ of reading from 3 to 30 ft/s (10:1 range)
 - 3) $\pm 2\%$ of reading from 0.4 to 20 ft/s (50:1 range)
 - e. Each sensor shall be individually calibrated and tagged accordingly against the manufacturer’s primary standards which must be accurate to within 0.1% of flow rate and traceable to the National Institute of Standards and Technology (NIST).
 - f. Maximum operating pressure of 400 psi and maximum operating temperature of 200°F continuous (220°F peak).
 - g. All wetted metal parts shall be constructed of 316 stainless steel.
 - h. Analog outputs shall consist of non interactive zero and span adjustments, a DC linearly of 0.1% of span, voltage output of 0-10 Vdc, and current output of 4-20 mA.
2. Magnetic Flow-Tube Type Flowmeter
 - a. Sensor shall be a magnetic flowmeter, which utilizes Faraday’s Law to measure volumetric fluid flow through a pipe. The flowmeter shall consist of two elements, the sensor and the electronics. The sensor shall generate a

- measuring signal proportional to the flow velocity in the pipe. The electronics shall convert this EMF into a standard current output.
- b. Electronic replacement shall not affect meter accuracy (electronic units are not matched with specific sensors).
 - c. Four-wire, externally powered, magnetic type flow transmitter with adjustable span and zero, integrally mounted to flow tube. Output signal shall be a digital pulse proportional to the flow rate (to provide maximum accuracy and to handle abrupt changes in flow). Standard 4-20 mA or 0-10 Vdc outputs may be used provided accuracy is as specified.
 - d. Flow Tube:
 - 1) ANSI class 150 psig steel
 - 2) ANSI flanges
 - 3) Protected with PTFE, PFA, or ETFE liner rated for 245°F minimum fluid temperature
 - e. Electrode and grounding material
 - 1) 316L Stainless steel or Hastelloy C
 - 2) Electrodes shall be fused to ceramic liner and not require o-rings.
 - f. Electrical Enclosure: NEMA 4, 7
 - g. Approvals:
 - 1) UL or CSA
 - 2) NSF Drinking Water approval for domestic water applications
 - h. Performance
 - 1) Accuracy shall be $\pm 0.5\%$ of actual reading from 3 to 30 ft/s flow velocities, and 0.015 ft/s from 0.04 to 3 ft/s.
 - 2) Stability: 0.1% of rate over six months.
 - 3) Meter repeatability shall be $\pm 0.1\%$ of rate at velocities > 3 ft/s.
3. Magnetic Insertion-Type Flowmeter
- a. Magnetic Faraday point velocity measuring device.
 - b. Insertion type complete with hot-tap isolation valves to enable sensor removal without water supply system shutdown.
 - c. 4-20 mA transmitter proportional to flow or velocity.
 - d. Accuracy: larger of 1% of reading and 0.2 ft/s.
 - e. Flow range: 0.2 to 20 ft/s, bidirectional.
 - f. Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards which must be accurate to within 0.1% of flow rate and traceable to the National Institute of Standards and Technology (NIST).
4. Vortex Shedding Flowmeter
- a. Output: 4-20 mA, 0-10 Vdc, 0-5 Vdc.
 - b. Maximum Fluid Temperature: 800°F (427 °C).
 - c. Wetted Parts: Stainless Steel.
 - d. Housing: NEMA 4X.
 - e. Turndown: 25:1 minimum.
 - f. Accuracy: 0.5% of calibrated span for liquids, 1% of calibrated span for steam and gases.
 - g. Body: Wafer style or ANSI flanged to match piping specification.
5. Transit-Time Ultrasonic Flowmeter
- a. Clamp-On transit-time ultrasonic flowmeter
 - b. Wide-Beam transducer technology
 - c. 4-20 mA transmitter proportional to flow or velocity.

d. Accuracy: 0.5% of reading in range 1 to 30 ft/s, 0.001 ft/s sensitivity.

Q. Thermal Energy Meters

1. Matched RTD, solid state, or thermistor temperature sensors with a differential temperature accuracy of $\pm 0.15^{\circ}\text{F}$.
2. Flow meter : See "Hydronic Flowmeters" section.
3. Unit accuracy of $\pm 1\%$ factory calibrated, traceable to NIST with certification.
4. NEMA 1 enclosure.
5. Panel mounted display.
6. UL listed.
7. Isolated 4–20 ma signals for energy rate and supply and return temperatures and flow.

R. Current Switches.

1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

S. Pressure Transducers.

1. Transducers shall have linear output signal and field-adjustable zero and span.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4–20 mA output, suitable mounting provisions, and block and bleed valves.
4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4–20 mA output, suitable mounting provisions, and 5-valve manifold.

T. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

U. Pressure-Electric (PE) Switches.

1. Shall be metal or neoprene diaphragm actuated, operating pressure rated for 0–175 kPa (0–25 psig), with calibrated scale minimum setpoint range of 14–125 kPa (2–18 psig) minimum, UL listed.
2. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application Electrically rated for pilot duty service (125 VA minimum) and/or for motor control.
3. Switches shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
4. Each pneumatic signal line to PE switches shall have permanent indicating gauge.

V. Occupancy Sensors. Occupancy sensors shall utilize Passive Infrared (PIR) and/or Microphonic Passive technology to detect the presence of people within a room. Sensors

shall be mounted as indicated on the approved drawings. The sensor output shall be accessible by any lighting and/or HVAC controller in the system. Occupancy sensors shall be capable of being powered from the lighting or HVAC control panel, as shown on the drawings. Occupancy sensor delay shall be software adjustable through the user interface and shall not require manual adjustment at the sensor.

W. Local Control Panels.

1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
2. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.11 WIRING AND RACEWAYS

- A. General. Provide wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
- B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

2.12 FIBER OPTIC CABLE SYSTEM

- A. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.
- B. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

PART 3 - EXECUTION

3.1 GENERAL

- A. Electrical work associated with the DDC control systems shall be provided by the DDC controls supplier.
- B. All electrical work shall be in accordance with Division 26 specifications.

- C. Hazard Classifications shall be in accordance with the electrical drawings.

3.2 EXAMINATION

- A. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- B. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and at the expense of—this contractor.

3.3 PROTECTION

- A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.4 COORDINATION

- A. Site
 - 1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
 - 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
- B. Submittals. See Section 23 09 23 Article 1.10 (Submittals).
- C. Test and Balance.
 - 1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 - 2. The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.

3. In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.

D. Life Safety.

1. Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock smoke detectors to air handlers for shutdown as specified in Section 23 09 93 (Sequences of Operation).
2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. Interlock smoke dampers to air handlers as specified in Section 23 09 93 (Sequences of Operation).
3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 28.

E. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:

1. All communication media and equipment shall be provided as specified in Section 23 09 23 Article 2.2 (Communication).
2. Each supplier of a controls product is responsible for the configuration, programming, start up, and testing of that product to meet the sequences of operation described in Section 23 09 93.
3. The contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.5 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install equipment in readily accessible locations as defined by Chapter 1 Article 100 Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

- E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.6 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 Article 1.8 (Codes and Standards).
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- C. Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.7 EXISTING EQUIPMENT

- A. Wiring. Interconnecting control wiring shall be removed and shall become the property of the contractor unless specifically noted or shown to be reused.
- B. Local Control Panels. Remove and deliver existing control panels to Owner.
- C. Repair. Unless otherwise directed, the contractor is not responsible for repair or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, the engineer is to be notified immediately.
- D. Indicator Gauges. Where these devices remain and are not removed, they must be made operational and recalibrated to ensure reasonable accuracy.
- E. Room Thermostats. Remove and deliver existing room thermostats to Owner unless otherwise noted. Patch and finish holes and marks left by removal to match existing walls.
- F. Electronic Sensors and Transmitters. Remove and deliver existing sensors and transmitters to Owner.
- G. Controllers and Auxiliary Electronic Devices. Remove and deliver existing controllers and auxiliary electronic devices to Owner.
- H. Damper Actuators, Linkages, and Appurtenances. Remove and deliver existing damper actuators, linkages and appurtenances to Owner.
- I. Control Valves. Replace existing control valves with new. Deliver removed control valves to Owner.

- J. Control Compressed Air Systems. Replace existing control compressed air systems with new unless otherwise noted. Deliver removed systems to Owner.
- K. Existing System Operating Schedule. Existing mechanical system may be disabled during this work.
- L. The scheduling of fans through existing or temporary time clocks or control system shall be maintained throughout the DDC system installation
- M. Install control panels where shown.
- N. Modify existing starter control circuits, if necessary, to provide hand-off-auto control of each controlled starter. If new starters or starter control packages are required, these shall be included as part of this contract.
- O. Patch holes and finish to match existing walls.

3.8 POWER

- A. Provide power to panels and devices requiring power.

3.9 WIRING

- A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification. Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.
- B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
- C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.
- D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.
- E. All wiring in mechanical, electrical, or service rooms – or where subject to mechanical damage – shall be installed in raceway at levels below 3 m (10ft).
- F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- G. Do not install wiring in raceway containing tubing.

- H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.
- I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.
- M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- O. Size of raceway and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- P. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- Q. Use color-coded conductors throughout with conductors of different colors.
- R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- S. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g. steam pipes or flues).
- T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- U. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
- V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.

- W. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- X. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.10 COMMUNICATION WIRING

- A. The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.
- B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling
- C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to manufacturer's instructions.
- G. All runs of communication wiring shall be unspliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.
- I. All communication wiring shall be labeled to indicate origination and destination data.
- J. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- K. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:

1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
4. An MS/TP EIA-485 network shall have no T connections.

3.11 FIBER OPTIC CABLE

- A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable andunjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3.12 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.
- D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.
- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m (1 ft) of sensing element for each 1 m²(1 ft²) of coil area.
- G. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 3 m (10 ft) downstream.
- H. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.

- I. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- J. Differential Air Static Pressure.
 - 1. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - 3. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - 4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - 5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 - 6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.
- K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.
- L. Install humidity sensors for duct mounted humidifiers at least 3 m (10 ft) downstream of the humidifier. Do not install filters between the humidifier and the sensor.

3.13 FLOW SWITCH INSTALLATION

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch according to manufacturer's instructions.

3.14 ACTUATORS

- A. General. Mount and link control damper actuators according to manufacturer's instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3. Provide all mounting hardware and linkages for actuator installation.

B. Electric/Electronic

1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.
2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.15 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the control system.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.

CAUTION

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

- B. Permanent warning labels shall be affixed to all motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.

CAUTION

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.16 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with control system address or termination number.
- B. All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.
- D. Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- E. Identify all other control components with permanent labels. All plug-in components shall be labeled such that label removal of the component does not remove the label.

- F. Identify room sensors related to terminal boxes or valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- H. Identifiers shall match record documents.

3.17 CONTROLLERS

- A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in Section 23 09 93 (Sequences of Operation).

3.18 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging.
- B. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See Section 23 09 93 (Sequences of Operation). If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in Appendix B to Section 23 09 93 may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- C. Software Programming.
 - 1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a. Text-based:
 - 1) Must provide actions for all possible situations
 - 2) Must be modular and structured
 - 3) Must be commented
 - b. Graphic-based:
 - 1) Must provide actions for all possible situations
 - 2) Must be documented
 - c. Parameter-based:
 - 1) Must provide actions for all possible situations

2) Must be documented.

D. Operator Interface.

1. Standard Graphics. Provide graphics for all mechanical systems, individual pieces of equipment, and floor plans of the building. This includes each hot water system, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List in Section 23 09 93.
2. The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface

E. Coordinate programming with capabilities of connected equipment to provide operation in accordance with Section entitled "Sequence of Operations for HVAC"; and complete, reliable, and safe system operation.

3.19 CONTROL SYSTEM CHECKOUT AND TESTING

A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.

1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

- b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
- c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action

3.20 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration.

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period.

Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.

- c. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - d. Interface to the building fire alarm system.
 - e. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance.

- 1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.
- 2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.21 CLEANING

- A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.22 DEMONSTRATION AND TRAINING

- A. Provide demonstration and training in accordance with the General Conditions.
- B. Training shall enable students to accomplish the following objectives.
 - 1. Day-to-day Operators:

- a. Proficiently operate the system
- b. Understand control system architecture and configuration
- c. Understand DDC system components
- d. Understand system operation, including DDC system control and optimizing routines (algorithms)
- e. Operate the workstation and peripherals
- f. Log on and off the system
- g. Access graphics, point reports, and logs
- h. Adjust and change system set points, time schedules, and holiday schedules
- i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
- j. Understand system drawings and Operation and Maintenance manual
- k. Understand the job layout and location of control components
- l. Access data from DDC controllers and ASCs
- m. Operate portable operator's terminals
- 2. Advanced Operators:
 - a. Make and change graphics on the workstation
 - b. Create, delete, and modify alarms, including annunciation and routing of these
 - c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
 - d. Create, delete, and modify reports
 - e. Add, remove, and modify system's physical points
 - f. Create, modify, and delete programming
 - g. Add panels when required
 - h. Add operator interface stations
 - i. Create, delete, and modify system displays, both graphical and others
 - j. Perform DDC system field checkout procedures
 - k. Perform DDC controller unit operation and maintenance procedures
 - l. Perform workstation and peripheral operation and maintenance procedures
 - m. Perform DDC system diagnostic procedures
 - n. Configure hardware including PC boards, switches, communication, and I/O points
 - o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
 - p. Adjust, calibrate, and replace system components
- 3. System Managers/Administrators:
 - a. Maintain software and prepare backups
 - b. Interface with job-specific, third-party operator software
 - c. Add new users and understand password security procedures
- C. Organize the training into sessions or modules for the three levels of operators listed above. (Day-to-Day Operators, Advanced Operators, System Managers and Administrators). Students will receive one or more of the training packages, depending on knowledge level required.
- D. Provide course outline and materials according to the "Submittals" article in Part 1 of this specification. Provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained and experienced in presenting this material.

- F. Classroom training shall be done using a network of working controllers representative of installed hardware.

3.23 SEQUENCES OF OPERATION

- A. See Specification Section '23 09 93 Sequence of Operations'.

3.24 CONTROL VALVE INSTALLATION

- A. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.
- B. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.
- C. Valves shall be installed in accordance with the manufacturer's recommendations.
- D. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
- E. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.
- F. Provide tags for all control valves indicating service and number. Tags shall be brass, 1.5 inch in diameter, with ¼ inch high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.

3.25 CONTROL DAMPER INSTALLATION

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼ in. larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm (1/8 in.) of each other.
- D. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.

- E. Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- G. Provide a visible and accessible indication of damper position on the drive shaft end.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.26 SMOKE DAMPER INSTALLATION

- A. The contractor shall coordinate all smoke and smoke/fire damper installation, wiring, and checkout to ensure that these dampers function properly and that they respond to the proper fire alarm system general, zone, and/or detector trips. The contractor shall immediately report any discrepancies to the engineer no less than two weeks prior to inspection by the code authority having jurisdiction.
- B. Provide complete submittal data to controls system subcontractor for coordination of duct smoke detector interface to HVAC systems.

3.27 DUCT SMOKE DETECTION

- A. Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."
- B. This Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

3.28 CONTROLS COMMUNICATION PROTOCOL

- A. General. The electronic controls packaged with this equipment shall communicate with the building direct digital control (DDC) system. The DDC system shall communicate with these controls to read the information and change the control setpoints as shown in the points list, sequences of operation, and control schematics. The information to be communicated between the DDC system and these controls shall be in the standard object format as defined in ANSI/ASHRAE Standard 135 (BACnet). Controllers shall communicate with other BACnet objects on the internetwork using the Read (Execute) Property service as defined in Clause 15.5 of Standard 135.

- B. Distributed Processing. The controller shall be capable of stand-alone operation and shall continue to provide control functions if the network connection is lost.
- C. I/O Capacity. The controller shall contain sufficient I/ O capacity to control the target system.
- D. The Controller shall have a physical connection for a laptop computer or a portable operator's tool.
- E. Environment. The hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40°C to 60°C (40°F to 140°F).
 - 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- F. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- G. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 30 days.
- H. Power. Controller shall be able to operate at 90% to 110% of nominal voltage rating.
- I. Transformer. Power supply for the Controller must be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

3.29 START-UP AND CHECKOUT PROCEDURES

- A. Start up, check out, and test all hardware and software and verify communication between all components.
 - 1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 2. Verify that all analog and binary input/output points read properly.
 - 3. Verify alarms and interlocks.
 - 4. Verify operation of the integrated system.

END OF SECTION

SECTION 23 09 93

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

1.2 DEFINITIONS

- A. See Section 23 09 23 DDC Controls for definitions.

1.3 ADMINISTRATION BUILDING – HOT WATER SYSTEM SEQUENCE

A. Hot Water System Run Conditions:

1. The hot water system shall be enabled to run whenever outside air temperature is less than 65°F (adj.). To prevent short cycling, the boiler system shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
2. The hot water system shall also run on call for dehumidification reheat by the Air Handling Unit or Rooftop Unit.

B. Boiler

1. The DDC system shall interface with the boiler control system through a BACnet compatible communications connection. The DDC system shall accept all inputs and outputs available from the boiler, and incorporate them into control, display, and operator interface design as appropriate.
2. The boiler shall be enabled when the hot water system is commanded on. The boiler shall be started after pump status is proven on and shall run subject to its own internal safeties and controls.
3. Boiler general alarm shall be received from the boiler control system
4. Hot Water Supply Temperature Setpoint: The boiler shall maintain a hot water supply temperature setpoint as determined by its own internal controls (provided by others).

C. Hot Water Pumps P-A-1 and P-A-2

1. The two pumps shall operate in a lead-lag sequence.
2. The lead pump shall be rotated on a periodic basis, to equalize pump runtime.
3. The lead pump shall run anytime the boiler is called to run and shall have a user definable delay (adj.) on stop.
4. If the lead pump fails, the lag pump shall be started.
5. Alarms shall be provided as follows:
 - a. Hot Water Pump Failure: Commanded on, but the status is off.
 - b. Hot Water Pump Running in Hand: Commanded off, but the status is on.
 - c. Hot Water Pump Runtime Exceeded: Status runtime exceeds a user definable limit.

- D. Existing Hot Water Circulation Pump
1. The circulation pump shall run anytime the boiler is called to run and the outside temperature is less than 65°F (adj.)
 2. Pump shall have a user definable (adj.) delay on stop
- E. Points list – Administration Building Hot Water System

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Boiler Start/Stop				x							x
Boiler Alarm			x							x	x
HW Pump P-A-1 Start/Stop				x							x
Hot Water Pump P-A-1 Failure			x							x	
HW Pump P-A-2 Start/Stop				x							x
Hot Water Pump P-A-2 Failure			x							x	
Circulation Pump Start/Stop				x							x
Outside Air Temp	x										x
Totals	1	0	3	4	0	0	0	0	0	3	6

1.4 ADMIN BLDG - AIR HANDLING UNIT CONTROLLER (AAC)

- A. The DDC system shall interface with the air handling unit control system through a BACnet compatible communications connection. The DDC system shall accept all inputs and outputs available from the air handling unit, and incorporate them into control, display, and operator interface design as appropriate.
- B. Run Conditions - The unit shall run whenever scheduled, when any zone is occupied, or when a definable number of unoccupied zones need heating or cooling.
- C. Freeze Protection: The unit shall shut down and generate an alarm upon receiving a freezestat status.
- D. High Static Shutdown: The unit shall shut down and generate an alarm upon receiving a high static shutdown signal.
- E. Return Air Smoke Detection: The unit shall shut down and generate an alarm upon receiving a return air smoke detector status.
- F. Supply Air Smoke Detection: The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.

- G. AHU Optimal Start: The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures.
- H. Supply Fan: The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.
 - 1. Alarms shall be provided as follows:
 - a. Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- I. Exhaust Fan: Exhaust fan F-A-1 shall operate during occupied periods, and shall be off during unoccupied periods. The DDC system shall monitor the exhaust fan status.
- J. Supply Air Duct Static Pressure Control: The controller shall measure duct static pressure and shall modulate the supply fan VFD speed to maintain a duct static pressure setpoint of 1.0 in H₂O (adj.). The supply fan VFD speed shall not drop below 30% (adj.).
 - 1. Alarms shall be provided as follows:
 - a. High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.
 - b. Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.
 - c. Supply Fan VFD Fault.
- K. Supply Air Temperature Setpoint - Optimized: The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling and heating requirements
 - 1. The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:
 - a. The initial supply air temperature setpoint shall be 55°F (adj.).
 - b. As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F (adj.).
 - c. As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 72°F (adj.).
 - 2. If all zones need heating, then the supply air temperature setpoint shall be reset for heating as follows:
 - a. The initial supply air temperature setpoint shall be 82°F (adj.).
 - b. As heating demand increases, the setpoint shall incrementally reset up to a maximum of 85°F (adj.).
 - c. As heating demand decreases, the setpoint shall incrementally reset down to a minimum of 72°F (adj.).
- L. Cooling Stages: The controller shall measure the supply air temperature and stage the cooling to maintain its cooling setpoint. To prevent short cycling, there shall be a user definable (adj.) delay between stages, and each stage shall have a user definable (adj.) minimum runtime.
 - 1. The cooling shall be enabled whenever:
 - a. Outside air temperature is greater than 60°F (adj.).

- b. AND the economizer (if present) is disabled or fully closed.
 - c. AND the supply fan status is on.
 - d. AND the heating is not active.
 - 2. Alarms shall be provided as follows:
 - a. High Supply Air Temp: If the supply air temperature is 5°F (adj.) greater than setpoint.
- M. Heating Coil Valve: The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.
 - 1. The heating shall be enabled whenever:
 - a. Outside air temperature is less than 65°F (adj.).
 - b. AND the supply fan status is on.
 - c. AND the cooling is not active.
 - 2. The heating coil valve shall open whenever:
 - a. Supply air temperature drops from 40°F to 35°F (adj.).
 - b. OR the freezestat is on.
 - 3. Alarms shall be provided as follows:
 - a. Low Supply Air Temp: If the supply air temperature is 5°F (adj.) less than setpoint.
- N. Economizer: The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F (adj.) less than the supply air temperature setpoint. The outside air dampers shall maintain a minimum adjustable position to provide 2240 cfm of outside (approximately 21% (adj.)) open whenever occupied.
 - 1. The economizer shall be enabled whenever:
 - a. Outside air temperature is less than 65°F (adj.).
 - b. AND the outside air temperature is less than the return air temperature.
 - c. AND the supply fan status is on.
 - 2. The economizer shall close whenever:
 - a. Mixed air temperature drops from 40°F to 35°F (adj.).
 - b. OR the freezestat is on.
 - c. OR on loss of supply fan status.
 - 3. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.
- O. Minimum Outside Air Ventilation - Fixed Percentage: The outside air dampers shall maintain a minimum adjustable position during building occupied hours and be closed during unoccupied hours. The minimum outside air shall balance the restroom exhaust system (F-A-1) at 2240 cfm.
- P. Dehumidification: The controller shall measure the return air humidity and override the cooling sequence to maintain return air humidity at or below 60% rh (adj.). Dehumidification shall be enabled whenever the supply fan status is on.

- Q. Mixed Air Temperature: The controller shall monitor the mixed air temperature and use as required for economizer control. Alarms shall be provided as follows:
1. High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
 2. Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).
- R. Filter High Differential Pressure.
1. Alarms shall be provided as follows:
 - a. Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).
- S. Return Air Temperature:
The controller shall monitor the return air temperature and use as required for setpoint control or economizer control (if present).
1. Alarms shall be provided as follows:
 - a. High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
 - b. Low Return Air Temp: If the return air temperature is less than 45°F (adj.).
- T. Supply Air Temperature:
The controller shall monitor the supply air temperature.
1. Alarms shall be provided as follows:
 - a. High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
 - b. Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).
- U. When the air handling unit is off, the outside air damper shall be closed and the return air damper shall be open.
- V. Points List - Administration Building Variable Air Volume Air Handling Units

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Supply Air Static Pressure	x									x	x
Filter High Differential Pressure			x						x	x	x
Mixed Air Temp	x								x		x
Return Air Temp	x								x		x
Supply Air Temp	x								x		x
Supply Fan VFD Speed		x							x		x
Heating Valve		x									x
Mixed Air Dampers		x									x
Freezestat			x							x	x
High Static Shutdown			x							x	x
Return Air Smoke Detector			x							x	x

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Supply Air Smoke Detector			x							x	x
Supply Fan VFD Fault			x							x	x
Supply Fan Status			x								x
Supply Fan Start/Stop				x							x
Cooling Stage 1				x					x		x
Cooling Stage 2				x					x		x
Exhaust Fan F-A-1 start/stop				x							x
Exhaust Fan F-A-1 status			x								
Supply Air Static Pressure Setpoint					x						x
Supply Air Temp Setpoint					x						x
Economizer Mixed Air Temp Setpoint					x						x
Dehumidification Setpoint					x						x
High Supply Air Static Pressure										x	
Low Supply Air Static Pressure										x	
Supply Fan Failure										x	
Supply Fan in Hand										x	
Supply Fan Runtime Exceeded										x	
High Supply Air Temp										x	
Compressor Runtime Exceeded										x	
Low Supply Air Temp										x	
Prefilter Change Required										x	x
Final Filter Change Required										x	x
High Mixed Air Temp										x	
Low Mixed Air Temp										x	
High Return Air Humidity										x	
Low Return Air Humidity										x	
High Return Air Temp										x	
Low Return Air Temp										x	
High Supply Air Temp										x	
Low Supply Air Temp										x	
Totals	4	3	7	3	4	0	0	0	7	25	23

1.5 ADMIN BLDG - ECONOMIZER EXHAUST FAN

- A. Run Conditions - Interlocked: The fan F-A-2 shall be interlocked to run whenever Air Handling Unit AHU-A-1 enters economizer mode. The relief damper shall open when economizer fan is energized.
- B. Fan: The fan shall have a user definable (adj.) minimum runtime.
- C. Economizer Exhaust Fan Points list

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Fan Start/Stop				x					x		x
Totals	0	0	0	1	0	0	0	0	1	0	1

1.6 ADMIN BLDG - VARIABLE AIR VOLUME TERMINAL UNIT (TYPICAL OF 8)

- A. Run Conditions - Scheduled: The unit shall run according to a user definable time schedule in the following modes:
 - 1. Occupied Mode: The unit shall maintain
 - a. 75°F (adj.) cooling setpoint
 - b. 72°F (adj.) heating setpoint.
 - 2. Unoccupied Mode (night setback): The unit shall maintain
 - a. 85°F (adj.) cooling setpoint.
 - b. 55°F (adj.) heating setpoint.
 - 3. Alarms shall be provided as follows:
 - a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 - b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
- B. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
- C. Zone Optimal Start: The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
- D. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
- E. Reversing Variable Volume Terminal Unit - Flow Control: The unit shall maintain zone setpoints by controlling the airflow through one of the following:

1. Occupied:
 - a. When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
 - b. When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).
 - c. When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature at its heating setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum heating airflow (adj.) until the zone is satisfied.
2. Unoccupied:
 - a. When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow (adj.).
 - b. When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
 - c. When zone temperature is less than its unoccupied heating setpoint, the controller shall enable heating to maintain the zone temperature at the setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the auxiliary heating airflow (adj.) until the zone is satisfied.
3. Electric Heat: The controller shall measure the zone temperature and modulate the heating to maintain its setpoint. To prevent short cycling, the heat shall have a user definable (adj.) minimum runtime. The heating shall be enabled whenever:
 - a. Outside air temperature is less than 65°F (adj.).
 - b. AND the zone temperature is below setpoint.
 - c. AND sufficient airflow is provided.

F. Points list - Administration Building – Variable Air Volume Terminal Unit

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Zone Temp (x8)	x								x		x
Zone Setpoint Adjust (x8)	x										x
Airflow (x8)	x								x		x
Zone Damper (x8)		x									x
Zone Override (x8)			x						x		x
Heat (x8)		x							x		x
Airflow Setpoint (x8)					x				x		x
Heating Mode (x8)						x			x		
Schedule (x8)								x			
Heating Setpoint (x8)									x		x

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Cooling Setpoint(x8)									x		x
High Zone Temp (x8)										x	
Low Zone Temp (x8)										x	
Totals	3	2	1	0	1	1	0	1	8	2	9

1.7 ADMIN BLDG - LABORATORY ROOFTOP UNIT CONTROLLER (AAC)

- A. The DDC system shall interface with the rooftop unit control system through a BACnet compatible communications connection. The DDC system shall accept all inputs and outputs available from the rooftop unit, and incorporate them into control, display, and operator interface design as appropriate.
- B. Run Conditions - Requested: The unit shall run whenever:
 1. The zone is occupied.
 2. Any hood is operating.
- C. Freeze Protection: The unit shall shut down and generate an alarm upon receiving a freezestat status.
- D. High Static Shutdown: The unit shall shut down and generate an alarm upon receiving a high static shutdown signal.
- E. Return Air Smoke Detection: The unit shall shut down and generate an alarm upon receiving a return air smoke detector status.
- F. Supply Air Smoke Detection: The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.
- G. AHU Optimal Start: The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures.
- H. Supply Fan: The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime. Alarms shall be provided as follows:
 1. Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- I. Supply Air Temperature Setpoint - Optimized: The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling and heating requirements
 1. The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:

- a. The initial supply air temperature setpoint shall be 55°F (adj.).
 - b. As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F (adj.).
 - c. As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 72°F (adj.).
 2. If more zones need heating than cooling, then the supply air temperature setpoint shall be reset for heating as follows:
 - a. The initial supply air temperature setpoint shall be 82°F (adj.).
 - b. As heating demand increases, the setpoint shall incrementally reset up to a maximum of 85°F (adj.).
 - c. As heating demand decreases, the setpoint shall incrementally reset down to a minimum of 72°F (adj.).
- J. Cooling Stages: The controller shall measure the supply air temperature and stage the cooling to maintain its cooling setpoint. To prevent short cycling, there shall be a user definable (adj.) delay between stages, and each stage shall have a user definable (adj.) minimum runtime.
 1. The cooling shall be enabled whenever:
 - a. Outside air temperature is greater than 60°F (adj.).
 - b. AND the economizer is disabled or fully open.
 - c. AND the supply fan status is on.
 - d. AND the heating is not active.
 2. Alarms shall be provided as follows:
 - a. High Supply Air Temp: If the supply air temperature is 5°F (adj.) greater than setpoint.
- K. Heating Coil Pump: The controller shall start the heating coil pump:
 1. On call for heat.
 2. If mixed air temperature is less than 45°F.
- L. Heating Coil Valve: The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.
 1. The heating shall be enabled whenever:
 - a. Outside air temperature is less than 65°F (adj.).
 - b. AND the supply fan status is on.
 - c. AND the cooling (if present) is not active.
 2. The heating coil valve shall open whenever:
 - a. Supply air temperature drops from 40°F to 35°F (adj.).
 - b. OR the freezestat (if present) is on.
 3. Alarms shall be provided as follows:
 - a. Low Supply Air Temp: If the supply air temperature is 5°F (adj.) less than setpoint.
- M. Economizer: The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F (adj.) less than the supply air temperature setpoint. The outside air dampers shall maintain a minimum adjustable position of 20% (adj.) open whenever occupied.
 1. The economizer shall be enabled whenever:

- a. Outside air temperature is less than 65°F (adj.).
 - b. AND the outside air temperature is less than the return air temperature.
 - c. AND the supply fan status is on.
 2. The economizer shall close whenever:
 - a. Mixed air temperature drops from 40°F to 35°F (adj.).
 - b. OR the freezestat (if present) is on.
 - c. OR on loss of supply fan status.
 3. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off.
 4. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.
 5. Minimum Outside Air Ventilation - Fixed Percentage:
The outside air dampers shall maintain a minimum adjustable position during building occupied hours and be closed during unoccupied hours.
 6. Outside air intake shall match exhaust requirements. Outside air flow shall be monitored by control system. Laboratory exhaust hood status shall be monitored by control system. Hood exhaust flow rates shall be assumed to be as follows:
 - a. Fume Hood 1 (6'): 1367 cfm
 - b. Fume Hood 2 (4'): 833 cfm
 - c. Canopy Hood 1 (north): 500 cfm
 - d. Canopy Hood 2 (south): 500 cfm
 7. The DDC system shall sum the operating hood exhaust air flow rates, and adjust the outside air damper to match intake flow to total exhaust flow.
- N. Dehumidification: The controller shall measure the return air humidity and override the cooling sequence to maintain return air humidity at or below 60% rh (adj.). Dehumidification shall be enabled whenever the supply fan status is on.
- O. Filter High Differential Pressure: The controller shall monitor the differential pressure switch across the filter. Alarms shall be provided as follows:
1. Filter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).
- P. Mixed Air Temperature: The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present). Alarms shall be provided as follows:
1. High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
 2. Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).
- Q. Return Air Humidity: The controller shall monitor the return air humidity and use as required for economizer control (if present) or humidity control (if present). Alarms shall be provided as follows:
1. High Return Air Humidity: If the return air humidity is greater than 70% (adj.).
 2. Low Return Air Humidity: If the return air humidity is less than 35% (adj.).

- R. Return Air Temperature: The controller shall monitor the return air temperature and use as required for setpoint control or economizer control (if present). Alarms shall be provided as follows:
1. High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
 2. Low Return Air Temp: If the return air temperature is less than 45°F (adj.).
- S. Supply Air Temperature: The controller shall monitor the supply air temperature. Alarms shall be provided as follows:
1. High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
 2. Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).
- T. Points List - Administration Building Variable Air Volume Air Handling Units

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Filter Differential Pressure			x						x		x
Mixed Air Temp	x								x		x
Return Air Humidity	x								x		x
Return Air Temp	x								x		x
Supply Air Temp	x								x		x
Heating Valve		x							x		x
Mixed Air Dampers		x							x		x
Freezestat			x						x	x	x
High Static Shutdown			x						x	x	x
Return Air Smoke Detector			x						x	x	
Supply Air Smoke Detector			x						x	x	
Supply Fan Status			x						x		x
Fume Hood 1 Exhaust Fan Status			x								x
Fume Hood 2 Exhaust Fan Status			x								x
Canopy Hood 1 Exhaust Fan Status			x								x
Canopy Hood 2 Exhaust Fan Status			x								x
Supply Fan Start/Stop				x					x		x
Cooling Stage 1				x					x		x
Cooling Stage 2				x					x		x
Supply Air Temp Setpoint					x				x		x
Economizer Mixed Air Temp Setpoint					x				x		x
Dehumidification Setpoint					x				x		x
High Supply Air Static Pressure										x	
Low Supply Air Static Pressure										x	
Supply Fan Failure										x	

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Supply Fan in Hand										x	
Supply Fan Runtime Exceeded										x	
High Supply Air Temp										x	
Compressor Runtime Exceeded										x	
Low Supply Air Temp										x	
Prefilter Change Required										x	x
Final Filter Change Required										x	x
High Mixed Air Temp										x	
Low Mixed Air Temp										x	
High Return Air Humidity										x	
Low Return Air Humidity										x	
High Return Air Temp										x	
Low Return Air Temp										x	
High Supply Air Temp										x	
Low Supply Air Temp										x	
Totals	4	2	10	3	3	0	0	0	18	22	22

1.8 SHB BOILER ROOM - COMBUSTION AIR SEQUENCE

- A. Boiler room combustion air system shall include the following components:
 1. Combustion air make-up air unit MUAU-SHB-1
 2. Louver LV-SHB-1
 3. Louver LV-SHB-2
 4. Louver LV-SHB-3
 5. Louver LV-SHB-4
 6. Louver LV-SHB-5
- B. The combustion air make-up air unit (MUAU-SHB-1) shall be running if any digester heat system or building heat system boiler is running (B-SHB-1, B-SHB-2, B-SHB-3, B-SHB-4, B-SHB-5). The combustion air make-up air unit operation shall be proven by a pressure switch monitoring fan differential pressure.
- C. When the building heat system is operating, the first floor exhaust fan F-SHB-1 shall be enabled. If first floor space temperature reaches 80°F, the fan shall be energized and set to 50% speed. As space temperature continues to rise, increase fan speed to maintain 80°F. If space temperature falls below 78°F, turn off exhaust fan.
- D. When the digester heat system is operating, the second floor exhaust fan F-SHB-2 shall be enabled. If first floor space temperature reaches 80°F, the fan shall be energized and

set to 50% speed. As space temperature continues to rise, increase fan speed to maintain 80°F. If space temperature falls below 78°F, turn off exhaust fan.

- E. Louvers shall be controlled as follows:
1. When boiler B-SHB-1 is running, the damper associated with louver LV-SHB-1, shall be open. Proof of damper open shall be provided by limit switch. If damper does not open when called, generate an alarm.
 2. When boiler B-SHB-2 is running, the damper associated with louver LV-SHB-2, shall be open. Proof of damper open shall be provided by limit switch. If damper does not open when called, generate an alarm.
 3. When boiler B-SHB-3 is running, the damper associated with louver LV-SHB-3, shall be open. Proof of damper open shall be provided by limit switch. If damper does not open when called, generate an alarm.
 4. When either boiler B-SHB-4 or B-SHB-5 is running, the damper associated with louver LV-SHB-4 shall be open. Proof of damper open shall be provided by limit switch. If damper does not open when called, generate an alarm.
 5. When combustion air make-up air unit MUAU-SHB-1 is running, the damper associated with louver LV-SHB-5 shall be open. Proof of damper open shall be provided by limit switch. If damper does not open when called, generate an alarm.
- F. Combustion air make-up air unit MUAU-SHB-1 shall be operated based on controls and alarms furnished by the make-up air unit manufacturer. The DDC system shall start, stop, and monitor the unit. Generally the combustion air MUAU will run continuously, as the digester heat system is required to produce heat on a year-round basis.
1. When MUAU-SHB-1 is started, associated intake louver LV-SHB-5 shall be opened.
- G. A differential pressure sensor monitoring differential pressure across the MUAU-SHB-1 fan shall verify fan is running. When differential pressure is above setpoint (0.1" wc, adjustable), the fan shall be considered to be running. If the differential pressure falls below setpoint, generate an alarm.
1. If either building heat boiler is operating, and the combustion air make-up air unit fails and louver LV-SHB-4 damper is not open, the building heat boilers shall be safely shutdown.
 2. If any digester heat boiler is operating, and the combustion air make-up air unit fails and the associated louver damper is not open (LV-SHB-1, LV-SHB-2 or LV-SHB-3), the digester heat boilers shall be safely shutdown. An alarm shall be generated.
- H. Points list for Combustion Air System (ASC)

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Fan start/stop				x							x
Fan Status			x							x	x
LV-SHB-1 Damper Open/Close				x							x
LV-SHB-2 Damper Open/Close				x							x
LV-SHB-3 Damper Open/Close				x							x
LV-SHB-4 Damper Open/Close				x							x
LV-SHB-5 Damper Open/Close				x							x
LV-SHB-1 Damper Status (limit switch)			x							x	
LV-SHB-2 Damper Status (limit switch)			x							x	
LV-SHB-3 Damper Status (limit switch)			x							x	
LV-SHB-4 Damper Status (limit switch)			x							x	
LV-SHB-5 Damper Status (limit switch)			x							x	
Totals	0	0	6	6	0	0	0	0	0	6	7

1.9 SHB BOILER ROOM - DIGESTER HEATING SYSTEM SEQUENCE

- A. The DDC system shall interface with the boilers control system through a BACnet compatible communications connection. The DDC system shall accept all inputs and outputs available from the boilers, and incorporate them into control, display, and operator interface design as appropriate.
- B. Three hot water boilers shall be dedicated to the digester heat system (B-SHB-1, B-SHB-2, and B-SHB-3). The heating system shall run continuously, digester heating is required year-round.
- C. When a boiler is commanded to start, the control system shall start the combustion air make-up air unit (if not already running), and open the louver associated with the boiler. Boilers shall not start until combustion air make-up air unit is proven operational (flow switch) and louver is proven open (limit switch).
- D. Two boilers shall be fueled with digester gas only, and one boiler with natural gas only.
- E. The preferred fuel shall be digester gas. The control system shall be set-up to provide digester heating with digester gas fuel as much as possible. The natural gas boiler shall be set-up as a back-up unit, to be used if needed (e.g. if there is insufficient digester gas available, or if the digester-gas-fired boilers are out of service).
- F. Digester gas is produced on site. Production quantities vary. Generally there should be enough digester gas produced to provide heating for digester heating, with some digester gas leftover. The leftover digester gas can be used for building heating (refer to next section) or it will automatically be directed to the waste gas burner.
- G. Digester gas operating pressure ranges between 5"wc and 12" wc. Normal operating pressure is 10" wc. Relief to waste gas burner occurs at 11.5" wc. Relief to atmosphere occurs at 12.0" wc.
- H. The control system shall modulate the boiler(s) firing digester gas to maintain gas pressure. The standby natural-gas-fired boiler shall be automatically started, and fired with natural gas to supplement the digester-gas-fired boiler, if there is not enough digester gas to maintain hot water supply temperature setpoint.
- I. If digester gas pressure falls too low, the digester gas fired boilers shall be turned off, and the natural gas fired boiler shall be modulated to maintain hot water supply temperature setpoint. Coordinate setpoint with boiler capability.
- J. Boiler firing shall be modulated to maintain hot water supply temperature setpoint (180°F, adjustable).
- K. If one digester-gas-fired boiler cannot maintain temperature, the second digester-gas-fired boiler shall be brought on-line. Each boiler shall be modulated to the same operating point, such that load is shared equally between them.
 - 1. If the second digester-gas-fired boiler is not available, the natural-gas-fired standby boiler shall be started, and modulated to maintain hot water supply

temperature setpoint. The digester-gas-fired boiler shall be modulated to maximize digester gas usage.

- L. If a boiler has a fault, it shall be turned off, and the next boiler shall be started, and an alarm shall be generated.
- M. If the capability to provide combustion air for the boilers is lost, the boilers shall be safely shutdown, and an alarm shall be generated.
- N. When a boiler is turned on, the associated primary hot water pump shall start. Pump status shall be verified by differential pressure switch. If differential pressure setpoint (3 psig, adjustable) is not met, shutdown boiler and generate an alarm.
- O. When the digester heat system is operating, secondary pump shall be turned on. Pump status shall be verified by differential pressure switch. If differential pressure setpoint (5 psig, adjustable) is not met, start standby pump, and generate an alarm.
- P. If both secondary pumps are down, the boilers shall be safely shutdown, and an alarm shall be generated.
- Q. Monitor hot water supply flow rate (FIT-1) to the distribution system. Modulate flow control valve (FCV-1) to maintain flow setpoint (240 gpm).
- R. The control system shall monitor and display hot water temperatures.
- S. The control system shall provide the following alarms to the PLC system:
 - 1. Digester heat system fault – any alarm that indicates that the digester heat system is not providing or cannot provide heat to the digesters (e.g. low hot water supply temperature).
 - 2. Digester heat system trouble alarm, to include all other alarms.
- T. To prevent short cycling, the boiler system shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
- U. Each boiler shall run subject to its own internal safeties and controls.
- V. Primary Hot Water Pump P-SHB-1
 - 1. Pump shall run anytime boiler is called to run and shall have a user definable delay (adj.) on stop.
 - 2. Failure: Commanded on, but the status is off.
 - 3. Running in Hand: Commanded off, but the status is on.
 - 4. Runtime Exceeded: Status runtime exceeds a user definable limit.
- W. Primary Hot Water Pump P-SHB-2
 - 1. Pump shall run anytime boiler is called to run and shall have a user definable delay (adj.) on stop.
 - 2. Failure: Commanded on, but the status is off.

3. Running in Hand:
 4. Commanded off, but the status is on.
 5. Runtime Exceeded: Status runtime exceeds a user definable limit.
- X. Primary Hot Water Pump P-SHB-3
1. Pump shall run anytime boiler is called to run and shall have a user definable delay (adj.) on stop.
 2. Failure: Commanded on, but the status is off.
 3. Running in Hand:
 4. Commanded off, but the status is on.
 5. Runtime Exceeded: Status runtime exceeds a user definable limit.
- Y. Secondary Hot Water Pump Lead/Standby Operation: The two hot water pumps shall operate in a lead/standby fashion.
1. The lead pump shall run first.
 2. On failure of the lead pump, the standby pump shall run and the lead pump shall turn off.
 3. The designated lead pump shall rotate upon one of the following conditions (user selectable):
 - a. manually through a software switch
 - b. if pump runtime (adj.) is exceeded
 - c. daily
 - d. weekly
 - e. monthly
- Z. Secondary Hot Water Pump P-SHB-4:
1. Failure: Commanded on, but the status is off.
 2. Running in Hand: Commanded off, but the status is on.
 3. Runtime Exceeded: Status runtime exceeds a user-definable limit.
- AA. Secondary Hot Water Pump P-SHB-5:
1. Failure: Commanded on, but the status is off.
 2. Running in Hand: Commanded off, but the status is on.
 3. Runtime Exceeded: Status runtime exceeds a user-definable limit.
- BB. Boiler Lead/Standby Operation: The three boilers shall operate in a lead/standby fashion when called to run and flow is proven.
1. The lead boiler shall run first.
 2. On failure of the lead boiler, the standby boiler shall run and the lead boiler shall turn off.
 3. The designated lead boiler shall rotate upon one of the following conditions: (user selectable):
 - a. manually through a software switch
 - b. if boiler runtime (adj.) is exceeded
 - c. daily
 - d. weekly
 - e. monthly

- CC. Boiler 1
1. Failure: Commanded on but the status is off.
 2. Running in Hand: Commanded off but the status is on.
 3. Runtime Exceeded: Status runtime exceeds a user definable limit.
- DD. Boiler 2
1. Failure: Commanded on but the status is off.
 2. Running in Hand: Commanded off but the status is on.
 3. Runtime Exceeded: Status runtime exceeds a user definable limit.
- EE. Lead Boiler Failure: The lead boiler is in failure and the standby boiler is on.
- FF. Hot Water Supply Temperature Setpoint: The boiler shall maintain a hot water supply temperature setpoint as determined by its own internal controls (provided by others).
- GG. Primary Hot Water Temperature Monitoring: The following temperatures shall be monitored:
1. Primary hot water supply.
 2. Primary hot water return.
 3. Alarms shall be provided as follows:
 - a. High Primary Hot Water Supply Temp: If greater than 200°F (adj.).
 - b. Low Primary Hot Water Supply Temp: If less than 100°F (adj.).
- HH. Status Panel: Provide status panel providing the following status points:
1. Secondary hot water supply temperature (digital display).
 2. Boiler on/off status for each boiler (indicator lights)
 3. Pump on/off status for each pump. (indicator lights)
- II. Points list for Digester Heating System

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Primary Hot Water Return Temp	x								x		x
Primary Hot Water Supply Temp	x										x
Secondary Hot Water Return Temp	x										x
Secondary Hot Water Supply Temp	x								x		x
Boiler B-SHB-1 Alarm			x							x	x
Boiler B-SHB-2 Alarm			x							x	x
Boiler B-SHB-3 Alarm			x							x	x
Primary Hot Water Pump P-SHB-1 Status			x								x

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Primary Hot Water Pump P-SHB-2 Status			x								x
Primary Hot Water Pump P-SHB-3 Status			x								x
Secondary Pump P-SHB-6 Status			x								x
Secondary Pump P-SHB-7 Status			x								x
Boiler B-SHB-1 Status			x						x		x
Boiler B-SHB-2 Status			x						x		x
Boiler B-SHB-3 Status			x						x		x
Primary Hot Water Pump P-SHB-1 Start/Stop				x							x
Primary Hot Water Pump P-SHB-2 Start/Stop				x							x
Primary Hot Water Pump P-SHB-3 Start/Stop				x							x
Secondary Pump P-SHB-6 Start/Stop				x							x
Secondary Pump P-SHB-7 Start/Stop				x							x
Boiler B-SHB-1 start/stop				x							x
Boiler B-SHB-2 start/stop				x							x
Boiler B-SHB-3 start/stop				x							x
Boiler B-SHB-1 Failure										x	x
Boiler B-SHB-2 Failure										x	x
Boiler B-SHB-3 Failure										x	x
Totals	4	0	11	8	0	0	0	0	4	6	23

1.10 SHB BOILER ROOM - BUILDING HEAT SYSTEM SEQUENCE

- A. The DDC system shall interface with the boilers control system through a BACnet compatible communications connection. The DDC system shall accept all inputs and outputs available from the boilers, and incorporate them into control, display, and operator interface design as appropriate.
- B. Two hot water boilers shall be dedicated to the building heat system (B-SHB-4 and B-SHB-5). The system shall run seasonally, and shall be started by a manual command in the fall and stopped by a manual command in the spring.
- C. When a boiler is commanded to start, the control system shall start the combustion air make-up air unit (if not already running), and open the louver associated with the boiler.

Boilers shall not start until combustion air make-up air unit is proven operational (flow switch) and louver is proven open (limit switch).

- D. Each building heat boiler shall be capable of firing either digester gas or natural gas.
- E. The building heat system shall derive as much heating as possible from the lead boiler firing digester gas. If additional heat is required, it shall be provided by the lag boiler firing natural gas.
- F. Digester gas system pressures are outlined in paragraph 1.9 G above.
- G. The control system shall modulate the boiler(s) firing digester gas to maintain gas pressure. The standby, natural-gas-fired boiler shall be automatically started, and fired to supplement the digester-gas fired boiler if there is not enough digester gas to maintain hot water supply temperature setpoint.
- H. If digester gas pressure falls too low, the digester gas fired boiler shall be turned off, and the natural gas fired boiler shall be modulated to supplement the digester-gas-fired boiler, and maintain hot water supply temperature setpoint.
- I. Boiler firing shall be modulated to maintain hot water supply temperature setpoint (180°F, adjustable).
- J. If one digester-gas-fired boiler cannot maintain hot water supply temperature, the standby boiler shall be brought on-line firing natural gas, to supplement the heat output of the digester-gas-fired boiler.
- K. If the capability to provide combustion air for the boilers is lost, the boilers shall be safely shutdown, and an alarm shall be generated.
- L. When a boiler is turned on, associated primary hot water pump shall start. Pump status shall be verified by differential pressure switch. If differential pressure setpoint (3 psig, adjustable) is not met, shutdown boiler and generate an alarm.
- M. When the building heat system is operating, secondary pump shall be turned on. Pump status shall be verified by differential pressure switch. If differential pressure setpoint (5 psig, adjustable) is not met, start standby pump, and generate an alarm.
- N. If both secondary pumps are down, the boilers shall be safely shutdown, and an alarm shall be generated.
- O. The DDC system shall provide the following alarms to the site PLC system:
 - 1. Fault - When system is shut down it shall be reported to the Boiler Manager as a System Shut Down.
 - 2. Trouble Alarm - When this system has an alarm condition, it shall be reported to the Boiler Manager as a General Alarm.

- P. To prevent short cycling, the boiler system shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
- Q. Each boiler shall run subject to its own internal safeties and controls.
- R. Primary Hot Water Pump P-SHB-4
1. Failure: Commanded on, but the status is off.
 2. Running in Hand: Commanded off, but the status is on.
 3. Runtime Exceeded: Status runtime exceeds a user definable limit.
- S. Primary Hot Water Pump B-SHB-5
1. Failure: Commanded on, but the status is off.
 2. Running in Hand: Commanded off, but the status is on.
 3. Runtime Exceeded: Status runtime exceeds a user definable limit.
- T. Secondary Hot Water Pump Lead/Standby Operation: The two secondary hot water pumps shall operate in a lead/standby fashion.
1. The lead pump shall run first.
 2. On failure of the lead pump, the standby pump shall run and the lead pump shall turn off.
 3. The designated lead pump shall rotate upon one of the following conditions (user selectable):
 - a. manually through a software switch
 - b. if pump runtime (adj.) is exceeded
 - c. daily
 - d. weekly
 - e. monthly
- U. Secondary Hot Water Pump P-SHB-6:
1. Failure: Commanded on, but the status is off.
 2. Running in Hand: Commanded off, but the status is on.
 3. Runtime Exceeded: Status runtime exceeds a user-definable limit.
- V. Secondary Hot Water Pump P-FSB-7:
1. Circulation Pump 2 Failure: Commanded on, but the status is off
 2. Circulation Pump 2 Running in Hand: Commanded off, but the status is on.
 3. Circulation Pump 2 Runtime Exceeded: Status runtime exceeds a user-definable limit.
- W. Boiler Lead/Standby Operation: The two boilers shall operate in a lead/standby fashion when called to run and flow is proven.
1. The lead boiler shall run first.
 2. On failure of the lead boiler, the standby boiler shall run and the lead boiler shall turn off.
 3. The designated lead boiler shall rotate upon one of the following conditions: (user selectable):
 - a. manually through a software switch

- b. if boiler runtime (adj.) is exceeded
- c. daily
- d. weekly
- e. monthly

X. Boiler B-SHB-4

- 1. Failure: Commanded on but the status is off.
- 2. Running in Hand: Commanded off but the status is on.
- 3. Runtime Exceeded: Status runtime exceeds a user definable limit.

Y. Boiler B-SHB-5

- 1. Failure: Commanded on but the status is off.
- 2. Running in Hand: Commanded off but the status is on.
- 3. Runtime Exceeded: Status runtime exceeds a user definable limit.
- 4. Lead Boiler Failure: The lead boiler is in failure and the standby boiler is on.

Z. Hot Water Supply Temperature Setpoint: The boiler shall maintain a hot water supply temperature setpoint as determined by its own internal controls (provided by others).

AA. Primary Hot Water Temperature Monitoring: The following temperatures shall be monitored:

- 1. Primary hot water supply.
- 2. Primary hot water return.
- 3. High Primary Hot Water Supply Temp: If greater than 200°F (adj.).
- 4. Low Primary Hot Water Supply Temp: If less than 100°F (adj.).

BB. Status Panel: Provide status panel providing the following status points:

- 1. Secondary hot water supply temperature (digital display).
- 2. Boiler on/off status for each boiler (indicator lights)
- 3. Pump on/off status for each pump. (indicator lights)

CC. Building Heating System (ASC) Points List

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Primary Hot Water Return Temp	x								x		x
Primary Hot Water Supply Temp	x										x
Secondary Hot Water Return Temp	x										x
Secondary Hot Water Supply Temp	x								x		x
Boiler B-SHB-4 Alarm			x							x	x
Boiler B-SHB-5 Alarm			x							x	x

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Primary Hot Water Pump P-SHB-4 Status			x								x
Primary Hot Water Pump P-SHB-5 Status			x								x
Secondary Pump P-SHB-8 Status			x								x
Secondary Pump P-SHB-9 Status			x								x
Boiler B-SHB-4 Status			x						x		x
Boiler B-SHB-5 Status			x						x		x
Primary Hot Water Pump P-SHB-4 Start/Stop				x							x
Primary Hot Water Pump P-SHB-5 Start/Stop				x							x
Secondary Pump P-SHB-8 Start/Stop				x							x
Secondary Pump P-SHB-9 Start/Stop				x							x
Boiler B-SHB-4 start/stop				x							x
Boiler B-SHB-5 start/stop				x							x
Boiler B-SHB-4 Failure										x	x
Boiler B-SHB-5 Failure										x	x
Totals	4	0	8	6	0	0	0	0	4	4	20

1.11 SHB BOILER ROOM VENTILATION SEQUENCE

- A. The boiler room ventilation system shall include the following components:
 1. First floor exhaust fan F-SHB-1
 2. Second floor exhaust fan F-SHB-2
- B. The first floor exhaust fan shall be enabled when the combustion air make-up air unit is operating. When first floor space temperature reaches setpoint (80°F, adjustable), the exhaust fan shall be energized at low speed (50%, adjustable). Modulate exhaust fan speed to maintain setpoint. When first floor space temperature falls below setpoint (78°F, adjustable), the exhaust fan shall be turned off.
 1. DDC system shall confirm that the damper associated with louver LV-SHB-4 is open before starting the first floor exhaust fan.
 2. If louver LV-SHB-4 is not open, the DDC system shall open it before starting exhaust fan.
- C. The second floor exhaust fan shall be enabled when the combustion air make-up air unit is operating. When second floor space temperature reaches setpoint (80°F, adjustable), the exhaust fan shall be started. Fan shall be at low speed (50%, adjustable) on start-up.

Modulate exhaust fan speed to maintain setpoint. When second floor space temperature falls below setpoint (78°F, adjustable), the exhaust fan shall be turned off.

1. DDC system shall confirm that the damper associated with louver LV-SHB-2, 3, or 4 is open before starting the second floor exhaust fan
 2. If louver LV-SHB-4 is not open, the DDC system shall open it before starting exhaust fan.
- D. High Zone Temp Alarm: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
- E. Fan Status: The controller shall monitor the fan status.
- F. Alarms, Safeties, additional requirements:
1. Fan Failure: Commanded on, but the status is off.
 2. Fan in Hand: Commanded off, but the status is on.
 3. Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

G. Boiler Room Ventilation Points List

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Boiler Room First Floor Temperature	x								x		x
Cooling Setpoint					x				x		x
High Zone Temp										x	
Boiler Room Second Floor Temperature	x								x		x
Cooling Setpoint					x				x		x
High Zone Temp										x	
Fan F-FSB-1 Status			x						x		x
Fan Start/Stop				x					x		x
Fan Failure										x	
Fan Speed		x									x
Fan Speed Feedback	x										
Fan in Hand										x	
Fan Runtime Exceeded										x	
Fan F-FSB-2 Status			x						x		x
Fan Start/Stop				x					x		x
Fan Failure										x	
Fan Speed		x									x
Fan Speed Feedback	x										
Fan in Hand										x	
Fan Runtime Exceeded										x	
Totals	3	2	2	2	1	0	0	0	6	7	7
Total Hardware (4)					Total Software (10)						

1.12 SECONDARY GALLERY VENTILATION (ELECTRIC CONTROLS)

- A. The make-up air unit and two exhaust fans shall run continuously.
- B. Freeze Protection: The make-up air unit shall shut down if freezestat trips.
- C. Outside Air Damper: The outside air damper shall open anytime the unit runs and shall close anytime the unit stops. The supply fan shall start only after the damper status has proven the damper is open.
- D. Supply Air Temperature Setpoint - Fixed: The controller shall monitor the supply air temperature and shall maintain a fixed supply air temperature setpoint of 50°F (adj.) by modulating the heating coil valve.

1.13 FINE SCREENING BUILDING - PROCESS AREA VENTILATION (ELECTRIC CONTROLS)

- A. Makeup air unit and two exhaust fans shall run continuously
- B. The make-up air unit fan and two exhaust fans shall have speed reduced to 50% of full speed (via variable-frequency drive), if the following conditions are met:
 - 1. Supply air temperature is 50°F (or less).
 - 2. Process area is occupied.
 - 3. No combustible gas is detected in process space.
- C. Freeze Protection: The make-up air unit shall shut down if freezestat trips.
- D. Outside Air Damper: The outside air damper shall open anytime the unit runs and shall close anytime the unit stops. The supply fan shall start only after the damper status has proven the damper is open.
- E. Supply Air Temperature Setpoint - Fixed: The controller shall monitor the supply air temperature and shall maintain a fixed supply air temperature setpoint of 50°F (adj.) by modulating the heating coil control valve.
- F. The heating shall be enabled whenever:
 - 1. Outside air temperature is less than 50°F (adj.).
 - 2. AND the supply air temperature is below heating setpoint.
 - 3. AND the fan status is on.
- G. The heating coil valve shall open to 100% (adj.) whenever the freezestat is on.

1.14 FINE SCREENING BLDG – HOT WATER HEATING SYSTEM

- A. Hot water system start/stop shall be manual.
- B. Hot Water Pump Lead/Standby Operation: The two hot water pumps shall operate in a lead/standby fashion.

1. The lead pump shall run first.
 2. On failure of the lead pump, the standby pump shall run and the lead pump shall turn off.
- C. The designated lead pump shall rotate upon one of the following conditions (user selectable):
1. manually through a software switch
 2. if pump runtime (adj.) is exceeded
 3. daily
 4. weekly
 5. monthly
- D. Hot Water Pump P-FSB-1
1. Failure: Commanded on, but the status is off.
 2. Running in Hand: Commanded off, but the status is on.
 3. Runtime Exceeded: Status runtime exceeds a user definable limit.
- E. Hot Water Pump P-FSB-2
1. Failure: Commanded on, but the status is off.
 2. Running in Hand: Commanded off, but the status is on.
 3. Runtime Exceeded: Status runtime exceeds a user definable limit.
- F. Coil Circulation Pump P-FSB-3: The coil circulation pump shall run anytime the boiler is called to run and shall have a user definable (adj.) delay on stop.
1. Circulation Pump Failure: Commanded on, but the status is off.
 2. Circulation Pump Running in Hand: Commanded off, but the status is on.
 3. Circulation Pump Runtime Exceeded: Status runtime exceeds a user definable limit.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 23 11 23

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes natural gas distribution systems as shown on the Contract Drawings:
 - 1. In buildings and outdoors above grade, with nominal operating pressure less than ½ psig.
 - 2. Outdoors, above- and below-grade, with nominal operating pressure of 15 psig.

1.2 REFERENCES

- A. Materials and installation shall comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society of Testing and Materials (ASTM):
 - a. ASTM A53 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. ASTM A105 – Specification for Carbon Steel Forgings for Piping Applications.
 - c. ASTM A193 – Specification for Carbon and Alloy Steel Bolting Materials for High-Temperature Service.
 - d. ASTM A194 – Specification for Carbon and Alloy Steel Nuts for Bolts for High-Temperature Service.
 - 2. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
 - a. ANSI/ASME B16.3 – Malleable Iron Threaded Fittings.
 - b. ANSI/ASME B16.5 – Pipe Flanges and Flanged Fittings.
 - c. ANSI/ASME B16.11 – Forged Steel Fittings, Socket-Welded and Threaded.
 - d. ANSI/ASME B16.9 – Factory-Made Wrought Steel Butt welding Fittings.
 - e. ANSI/ASME B16.33 – Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psig.
 - f. ANSI/ASME B16.38 – Large Metallic Valves for Gas Distribution (Manually Operated, NPS 2-1/2 to 12, 125 psig maximum).
 - 3. American National Standards Institute / American Welding Society (ANSI/AWS):
 - a. ANSI/AWS D10.12 – Recommended Practices and Procedures for Welding Low Carbon Steel.
 - 4. American National Standards Institute/National Fire Protection Association (ANSI/NFPA):
 - a. ANSI/NFPA 70 – National Electrical Code.
 - 5. The International Fuel Gas Code.

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
1. Vertical and horizontal runs, offsets, and transitions.
 2. Clearances for access above and to the side.
 3. Show dimensions and details, including connections.
 4. Support locations, type of support, and weight on each support.
 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1.5 QUALITY ASSURANCE

- A. Installer's Qualifications
1. Workers and their supervisors performing the Work of this section shall be personally experienced in installing Natural Gas Piping Systems and shall have been regularly employed by a company specializing in Natural Gas Piping Systems with five years minimum experience.
 2. Welders shall be certified and shall have a minimum of 3 years of welding experience.
- B. Regulatory Requirements
1. Natural gas piping systems and appurtenances shall comply with the Fuel Gas Code.
- C. Qualifications
1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

PART 2 - PRODUCTS

2.1 NATURAL GAS PIPING SYSTEMS

- A. Service
1. Site natural gas distribution system pressure: 15 psig (nominal)
 2. Building natural gas system pressure: less than ½ psig (14 inches water column)
- B. Pipe
1. 1/2 inch to 1-1/2 inch – Carbon steel, ASTM A53, type E, grade A, schedule 40.

2. 2 inch to 6 inch – Carbon steel, ASTM A53, type E, grade A, schedule 40.
- C. Fittings
1. Malleable Iron Fittings: Class 150, ANSI/ASME B16.3, threaded.
 2. 2 inch to 6 inch – Carbon steel, ASTM A234, butt-weld type, schedule 40, ANSI/ASME B16.9.
- D. Shutoff Valves
1. 1/2 inch to 1 inch - Ball valve, carbon steel body and ball, flanged ends, Teflon primary seats and seals, emergency stem seals, metal secondary seats, lockable carbon steel handle, 150 psig minimum rating at 100 degrees F, Underwriter's Laboratories (UL) Listed for natural gas service.
 - a. Jamesbury Corp. Style AZ, Double-Seal, with Fire-Tite design.
 - b. approved equal.
 2. 1-1/4 inch to 2 inch - Ball valve, carbon steel body and ball, screwed ends, Teflon primary seats and seals, emergency stem seals, metal secondary seats, lockable carbon steel handle, 150 psig minimum rating at 100 degrees F, ANSI/ASME B16.33.
 - a. Jamesbury Corp. Style AZ, Double-Seal, with Fire-Tite design.
 - b. approved equal.
 3. 2-1/2 inch to 6 inch – Lubricated plug valve, cast iron body, 316 stainless steel plug, flanged ends, lockable steel lever actuator, rated 125 psig WOG, ANSI/ASME B16.38. Suitable for natural gas service. Valves 6" and larger shall have worm gear operator.
- E. Flanges
1. 1/2 inch to 1-1/2 inch – Carbon steel, ASTM A105, 150 lb., standard face, socket weld, ANSI/ASME B16.5.
 2. 2 inch to 6 inch – Carbon steel, ASTM A105, slip-on or weld neck, 150 lb., standard face, ANSI/ASME B16.5.
- F. Flange Gaskets – Material for gaskets shall be capable of withstanding the design temperature and pressure of the piping system, and the chemical constituents of the gas being conducted, without change to its chemical and physical properties. Acceptable materials include: metal, metal-jacketed asbestos (plain or corrugated), aluminum o-rings and spiral-wound metal gaskets
- G. Flange Bolts – Stainless steel, ASTM A193, grade B8M, cap screw, hex-head.
- H. Flange Nuts – Stainless steel, ASTM A194, grade B8M, hex-head.
- I. HDPE-to-Steel Transition Fitting: one-piece fitting providing transition from High Density Polyethylene (HDPE) to carbon steel. Fitting shall include HDPE section with fusion butt-weld end, and carbon steel section with butt-weld end. Transition shall be made with double O-ring seal, and shall be tamper proof and gas-tight. Fitting shall be rated for minimum 40 psig gas pressure. Fitting shall be as manufactured by Central Plastics Company, or approved equal.
- J. Pressure gauges shall be industrial general service gauges, 4-1/2 inch dial, with isolation valve and pulsation dampener. Scale range shall be 0-20 inches water. Accuracy shall be

1% of full scale. Wika series 612.34 or approved equal. Provide pressure gauges where gas piping enters building.

PART 3 - EXECUTION

3.1 GENERAL

- A. Natural gas piping systems shall be installed in accordance with the Fuel Gas Code and the Section "Common Work Results for HVAC Piping."
- B. Provide full-line-size dirt leg and isolation at connections to fuel-burning equipment.
- C. Runouts shall be taken from the top of main, at 45 or 90 degrees.
- D. Piping within buildings shall be supported in accordance with the Fuel Gas Code and the Section entitled "Hangers And Supports For HVAC Piping and Equipment."
- E. Natural gas piping systems shall be electrically continuous and bonded to a grounding electrode, as defined by the National Electrical Code, ANSI/NFPA 70
- F. Underground piping constructed of carbon steel shall be coated.

3.2 JOINT TYPE SELECTION

- A. Pipe sizes 1/2 inch to 1-1/2 inch shall have socket welded type joints or threaded.
- B. Pipe sizes 2 inch to 6 inch shall have buttwelded-type joints.
- C. Welding shall be in accordance with ANSI/AWS D10.12.
- D. Flange joints shall be used at valve and equipment connections.

3.3 INSPECTION

- A. Natural gas piping systems shall be subject to inspection by the Owner's designated Inspector and by local permitting Authorities during and after installation.
- B. Inspectors shall, at all times, have access to any place where work in preparation or progress. Contractor shall provide sufficiently safe and proper facilities for such access and inspection.

3.4 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.

- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.5 INSTALLATION

- A. Install piping system as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Vents associated with equipment gas trains shall be piped to outdoors and provided with protection cap.

3.6 PRESSURE TEST

- A. Prior to pressure test, piping system shall be blown clear of debris.
- B. Natural gas piping systems shall be tested in accordance with the Fuel Gas Code. Test medium shall be air, nitrogen, or carbon dioxide. Refer to Section entitled HVAC Pipe Pressure Tests.

3.7 PURGING

- A. Natural gas piping systems shall be placed in operation in accordance with the Fuel Gas Code. If the system is filled with air, the air shall be purged with an inert gas prior to filling with natural gas.

3.8 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.9 IDENTIFICATION

- A. Identify piping and valves as specified in Section "Identification for HVAC Piping and Equipment".

3.10 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 11 24

DIGESTER GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes digester gas piping with a maximum of 1.0 psig nominal operating pressure in buildings as shown on the Contract Drawings.

1.2 REFERENCES

- A. Materials and installation shall comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. International Fuel Gas Code
 - 2. American Society of Testing and Materials (ASTM):
 - a. ASTM A312 – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
 - b. ASTM A403 – Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
 - c. ASTM A193 – Specification for Carbon and Alloy Steel Bolting Materials for High-Temperature Service.
 - d. ASTM A194 – Specification for Carbon and Alloy Steel Nuts for Bolts for High-Temperature Service.
 - 3. American Society of Mechanical Engineers (ASME):
 - a. ASME B16.5 – Pipe Flanges and Flanged Fittings
 - b. ASME B16.11 – Forged Steel Fittings, Socket-Welded and Threaded
 - c. ASME B16.9 – Factory-Made Wrought Steel Buttwelding Fittings
 - d. ASME B16.33 – Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psig
 - e. ASME B16.38 – Large Metallic Valves for Gas Distribution (Manually Operated, NPS 2-1/2 to 12, 125 psig maximum).
 - 4. American Welding Society (AWS):
 - a. AWS D10.12 – Recommended Practices and Procedures for Welding Low Carbon Steel
 - 5. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
 - 1. Vertical and horizontal runs, offsets, and transitions.
 - 2. Clearances for access above and to the side.

3. Show dimensions and details, including connections.
4. Support locations, type of support, and weight on each support.
5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1.5 QUALITY ASSURANCE

- A. Installer's Qualifications
 1. Workers and their supervisors performing the Work of this section shall be personally experienced in installing Digester Gas Piping Systems and shall have been regularly employed by a company specializing in Gas Piping Systems with five years minimum experience.
 2. Welders shall be certified and shall have a minimum of 3 years of welding experience.
- B. Regulatory Requirements
 1. Digester gas piping systems and appurtenances shall comply with the Fuel Gas Code.
- C. Qualifications
 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

PART 2 - PRODUCTS

2.1 DIGESTER GAS PIPING SYSTEMS

- A. Service
 1. Media: digester gas
 2. Nominal system operating pressure: up to 13 inches water column.
 3. Heating value: approximately 600 Btu/ cu. ft.
 4. Specific gravity: 0.9
- B. Pipe
 1. 1/2 inch to 2 inch – Stainless steel, ASTM A312, Type 316, schedule 40S
 2. 2-1/2 inch to 8 inch – Stainless steel, ASTM A312, Type 316, schedule 10S.

C. Fittings

1. 1/2 inch to 2 inch – Stainless steel, ASTM A403, Type 316, threaded, schedule 40S, ANSI/ASME B16.9
2. 2-1/2 inch to 8 inch – Stainless steel, ASTM A403, Type 316, butt-weld type, schedule 40S, ANSI/ASME B16.9.

D. Shutoff Valves

1. 1/2 inch to 2 inch - Ball valve, type 316 stainless steel body and ball, threaded or flanged ends, Teflon primary seats and seals, emergency stem seals, metal secondary seats, lockable stainless steel handle, 150 psig minimum rating at 100 degrees F, Underwriter's Laboratories (UL) Listed for gas service.
 - a. Jamesbury Corp. Series 4000 or 7000, Double-Seal, with Fire-Tite design.
 - b. approved equal.
2. 2-1/2 inch to 8 inch – Lubricated plug valve, stainless steel body, Type 316 stainless steel plug, flanged ends, lockable stainless steel lever actuator, rated 125 psig WOG, ANSI/ASME B16.38, approved for gas service. Valves 6" and larger shall have worm gear operator.

E. Drip Traps

1. Factory-fabricated assembly designed for removal of liquids from digester piping system. Unit shall provide drainage of liquids without gas escape.
2. Unit shall have 1" connections and a minimum of 3 quarts liquid storage capacity. Unit shall be designed for manual operation, with one-quarter-turn lever handle. Horizontal handle position shall indicate trap is closed, and vertical handle position shall indicate trap is open.
3. Drip trap shall have aluminum construction with stainless steel internals, and shall be rated for 5 psig working pressure.
4. Groth model 8460 or approved equal.

F. Flame Trap

1. Flame trap shall include thermal valve and flame arrestor in a factory assembled unit. Flame trap shall be full line size, and shall have 150 lb flanged connections. Unit shall be suitable for mounting in horizontal or vertical pipe.
2. Thermal valve shall be a plug-type shutoff valve with spring actuator and thermal element release. Thermal element shall release at 260°F gas temperature, and shall be replaceable without disassembling the valve. Valve shall include a sight glass which allows visual observation of plug position indicator. Construction shall be aluminum with stainless steel internal parts.
3. Flame arrestor shall have housing constructed of cast aluminum. Bank assembly shall be all-aluminum, and shall be wafer design to facilitate removal from the housing for inspection and cleaning. Net free area through the bank shall be a minimum of three times the area of the associated pipe connection. Flame arrestor shall be Factory Mutual approved.
4. Flame trap shall be Groth Model 8500A or approved equal.

G. Flanges

1. 2-1/2 inch to 8 inch – Type 316 stainless steel, ASTM A182, stub-end with 150# ANSI Slip-on, ASME B16.5, raised face or flat face to match connecting component.

- H. Flange Gaskets – Material for gaskets shall be capable of withstanding the design temperature and pressure of the piping system, and the chemical constituents of the gas being conducted, without change to its chemical and physical properties. Acceptable materials include: PTFE or approved equal.
- I. Flange Bolts – Stainless steel, ASTM A193, grade B8M, cap screw, hex-head.
- J. Flange Nuts – Stainless steel, ASTM A194, grade B8M, hex-head.
- K. Pressure gauges shall be industrial general service gauges, 4-1/2 inch dial, with isolation valve. All components shall be stainless steel. Scale range shall be 0-20 inches water. Accuracy shall be 1% of full scale. Wika series 612.34 or approved equal. Provide pressure gauges at each connection to equipment.

PART 3 - EXECUTION

3.1 GENERAL

- A. Digester gas piping systems shall be installed in accordance with the Fuel Gas Code and the Section “Common Work Results for HVAC Piping.”
- B. Pitch digester gas piping a minimum of 0.125” per foot in the direction of flow, except where noted.
- C. Provide full-line-size drip leg and minimum 1” diameter drain valve at rises in pipe. Provide piping from drain valve to floor drain.
- D. Provide full-line-size drip leg and minimum 1” diameter drain valve at fuel-burning equipment.
- E. Piping within buildings shall be supported in accordance with the Fuel Gas Code and the Section entitled “Hangers And Supports For HVAC Piping and Equipment.”
- F. Digester gas piping systems shall be electrically continuous and bonded to a grounding electrode, as defined by the National Electrical Code, ANSI/NFPA 70.

3.2 JOINT TYPE SELECTION

- A. Pipe sizes 1/2 inch to 8 inch shall have butt-weld or flange joints.
- B. Welding shall be in accordance with ANSI/AWS D10.12.
- C. Flange joints shall be used at valve and equipment connections.

3.3 INSPECTION

- A. Digester gas piping systems shall be subject to inspection by the Owner’s designated Inspector and by local permitting Authorities during and after installation.

- B. Inspectors shall, at all times, have access to any place where work in preparation or progress. Contractor shall provide sufficiently safe and proper facilities for such access and inspection.

3.4 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.5 INSTALLATION

- A. Install piping as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Vents associated with equipment gas trains shall be piped to outdoors and provided with protection cap.

3.6 PRESSURE TEST

- A. Prior to pressure test, piping system shall be blown clear of debris.
- B. Digester gas piping systems shall be tested in accordance with the Fuel Gas Code. Test medium shall be air, nitrogen, or carbon dioxide. Refer to Section entitled HVAC Pipe Pressure Tests.

3.7 PURGING

- A. Digester gas piping systems shall be placed in operation in accordance with the Fuel Gas Code. If the system is filled with air, the air shall be purged with an inert gas prior to filling with gas.

3.8 PAINTING

- A. All digester gas piping shall be painted. Perform field painting in accordance with the Section "Painting".

3.9 IDENTIFICATION

- A. Identify piping and valves as specified in Section “Identification for HVAC Piping and Equipment”.

3.10 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe, fittings, valves, and specialties for the following hydronic piping systems as shown on the Contract Drawings.
 - 1. Digester Heating Hot Water System
 - 2. Building Heating Hot Water System
 - 3. Fine Screens Building Hot Water System
 - 4. Administration Building Hot Water System

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM A47 – Specification for Ferritic Malleable Iron Castings.
 - b. ASTM A53 – Specification for Pipe. Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - c. ASTM A106 – Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - d. ASTM A126 – Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - e. ASTM A193 – Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - f. ASTM A194 – Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
 - g. ASTM A234 – Specification for Piping fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
 - h. ASTM B88 – Specification for Seamless Copper Water Tube.
 - i. ASTM B306 – Specification for Copper Drainage Tube (DWV).
 - j. ASTM D1785 – Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - k. ASTM D2466 – Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - l. ASTM D2467 – Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - 2. American National Standards Institute (ANSI)
 - a. NSF/ANSI 61 Drinking Water System Components- Health Effects.
 - 3. American Society of Mechanical Engineers (ASME)
 - a. ASME B1.20.1 – Pipe Threads, General Purpose.
 - b. ASME B16.1 – Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
 - c. ASME B16.3 – Malleable-Iron Threaded Fittings, Classes 150 and 300.
 - d. ASME B16.5 – Pipe Flanges and Flanged Fittings.

- e. ASME B16.11 – Forged Fittings, Socket Welding and Threaded.
- f. ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- g. ASME B16.39 – Pipe Unions, Malleable Iron Threaded.
- h. ASME B31.9 – Building Services Piping.
- i. ASME Boiler and Pressure Vessel Code.

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of hydronic piping and suspension system components with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
 - 1. Vertical and horizontal runs, offsets, and transitions.
 - 2. Clearances for access above and to the side.
 - 3. Show dimensions and details, including connections.
 - 4. Support locations, type of support, and weight on each support.
 - 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 DESIGN CONDITIONS

- A. Building Heat Hot Water Piping System:
 - 1. Operating Temperature: 180 deg F maximum
 - 2. Fill Pressure: 4 psig
 - 3. Operating Pressure: 30 psig
- B. Digester Heat Hot Water Piping System:
 - 1. Operating Temperature: 180 deg F maximum
 - 2. Fill Pressure: 4 psig.
 - 3. Operating Pressure: 30 psig

1.5 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: “Catalog cuts” and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- C. Submit schedule of Cv values for calibrated balancing valves and triple duty valves.

1.6 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

B. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Materials and Construction:

1. Steel Pipe: ASTM A53, Type E (electric-resistance welded), Grade A, Schedule 40, black steel, plain ends.
2. Malleable Iron Fittings: Class 150, ANSI/ASME B16.3, threaded.
3. Malleable Iron Unions: Class 150, brass seat, ANSI/ASME B16.39, threaded.
4. Steel Fittings: Wrought steel fittings, ASTM A234, wall thickness to match adjoining pipe.
5. Steel Flanges: Wrought-, cast-, or forged-steel flanges, ASME B16.5, weldneck or slip-on, flat or raised face.
6. Flanged Fittings: Wrought-, cast-, or forged-steel fittings, ASME B16.5, flat or raised face.
7. Flange Bolts and Nuts: Bolts shall be stainless steel hex-head cap screw, ASTM A193, grade B8M. Nuts shall be stainless steel hex-head, ASTM A194, grade B8M.
8. Grooved Mechanical-Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47 (ASTM A47M), Grade 32510 malleable iron; ASTM A53, Type F, E, or S. Grade B fabricated steel; or ASTM A106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.
9. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.2 BALL VALVES

A. Manufacturers:

1. Milwaukee valve Corp.
2. Nibco
3. Stockham
4. Neles-Jamesbury
5. Watts Regulator
6. Approved Equal

B. Materials and Construction:

1. 1/4 inch to 3 inch: Bronze body, solder or threaded ends, Teflon seats and seals, plastic-covered steel handle, minimum 150 psi rated at system operating temperatures.

2.3 BUTTERFLY VALVES

- A. 3" to 12" – Butterfly valve, iron body, lug type, aluminum bronze disc, stainless steel trim, EPDM seat and O-rings, 150 psi. Valve sizes 3" to 4" shall have lever actuator. Valves larger than 4" shall have worm-gear actuator. Manual valves installed 7'-0" or higher above finished floor shall be provided with chain-wheel actuators. Valves shall be lockable. Provide electric actuator with limit switches where shown on drawings. Manufacturer shall be Keystone or approved equal.

2.4 CHECK VALVES

- A. Manufacturers:
 1. Milwaukee valve Corp.
 2. Nibco
 3. Stockham
 4. Approved Equal
- B. Materials and Construction:
 1. 3/4 inch to 2 inch: Swing check, bronze body, solder or threaded, bronze disc, 150 psi, 250 deg F maximum operating temperature.
 2. 2-1/2 inch to 12 inch: Swing check, iron body, bronze mounted, flanged, bolted cover, 125 psig at 405 deg F.

2.5 TRIPLE-DUTY VALVES

- A. Manufacturers:
 1. Bell and Gossett
 2. Watts Regulator
 3. Grinnell
 4. Approved Equal
- B. Materials and Construction:
 1. Straight pattern, 175-psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features.

2.6 CALIBRATED BALANCING VALVES

- A. Manufacturers:
 1. Bell & Gossett
 2. Armstrong Pumps
 3. Taco
 4. Approved Equall
- B. Materials and Construction

1. 1/2 inch to 2 inch: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
2. 2-1/2 inch and Larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
3. Select valve size based on flow rate in pipe branch and minimum sufficient pressure drop for accurate flow reading, 3-5 psi.
4. Provide to Owner two portable differential pressure meters supplied by the manufacturer of calibrated balancing valves.

2.7 SUCTION DIFFUSERS

A. Manufacturers:

1. Bell and Gossett
2. Taco
3. Mueller Steam Specialty
4. Aurora Pump
5. Approved Equal

B. Materials and Construction:

1. Angle or straight pattern, 175-psig (1200-kPa) pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory- or field-fabricated support.

2.8 WYE-PATTERN STRAINERS

A. Manufacturers:

1. Nibco
2. Watts Regulator
3. Mueller Steam Specialty
4. Tyco
5. Approved Equal

B. Materials and Construction:

1. 125-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2 inches and larger, threaded connections for 2 inches and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Garlock
2. Metraflex
3. Red Valve Company, Inc

4. Approved Equal

B. Materials and Construction:

1. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.
2. Molded, double-arch spherical connector/expansion joint(s). Molded spherical body shall be manufactured using multiple plies of nylon tire cord fabric bonded within the neoprene elastomer (to avoid exposure to atmosphere or media) and reinforced with a spring steel wire. Floating/rotatable flanges shall be zinc-coated plate steel with drilled bolt holes in accordance with ANSI 150# standard. The rated design pressure of the molded body shall have a minimum 3:1 safety factor (burst to operating pressure) based on a maximum operating temperature of 220 deg F and shall also be capable of 26-inch Hg vacuum. Neoprene/nylon double-sphere rubber connector/expansion joint(s) shall have a 2-year warranty when installed in accordance with installation instructions.

2.10 MANUAL AIR VENTS

A. Manufacturers:

1. Bell and Gossett
2. Hoffman
3. Watts Regulator
4. Approved Equal

B. Materials and Construction:

1. Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with 1/8-inch discharge connection and 1/2-inch inlet connection.

2.11 AUTOMATIC AIR VENTS

A. Manufacturers:

1. Bell and Gossett
2. Hoffman
3. Taco
4. Watts Regulator
5. Approved Equal

B. Materials and Construction:

1. Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with 1/4-inch discharge connection and 1/2-inch inlet connection.

2.12 EXPANSION TANKS

A. Manufacturers:

1. Bell & Gossett

2. Armstrong Pumps
3. Taco
4. Approved equal

B. Materials and Construction:

1. Bladder-Type. Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity by a flexible bladder securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Support vertical tanks with steel legs or base. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Gage Glass: Full height with dual manual ball type shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.
2. Provide tank volume and acceptance volume as noted on drawings..

2.13 LOW-POINT DRAIN VALVES

- A. Low-point drain valves shall be 3/4-inch hose end ball valve with chained gasketed cap rated for system working temperature and pressure.

2.14 AIR SEPARATORS

A. Manufacturers:

1. Bell & Gossett
2. Armstrong Pumps
3. Taco
4. Approved Equal

B. Materials and Construction:

1. Cast iron or welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; in-line or tangential inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity.

2.15 BYPASS CHEMICAL FEEDERS

- A. Welded steel construction; 125-psig working pressure; 1.8-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

2.16 PRESSURE REDUCING VALVES

- A. Diaphragm-operated pressure reducing valve, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field

adjustment. Pressure-reducing valves shall be Armstrong Pumps, Conbraco Industries, Bell & Gossett, Watts Industries, or approved equal.

2.17 MAKE-UP WATER METERS

- A. Nutating disc style, positive displacement flow meter, designed for low water volumes. Conform to AWWA C-700 for positive displacement meters. Maincase and bottom cover shall be bronze with threaded end connections. Measuring chamber, integral strainer, nutating disc, and thrust roller shall be thermoplastic. Register housing shall be bronze. Register shall have a straight-reading odometer-type display, reading in gallons. Meter shall be Mueller System Hersey 420 or approved equal.

2.18 HOT WATER FLOW METER (FLOW INDICATING TRANSMITTER)

- A. Description: Inline or insertion type; measures flow directly in gallons per minute (liters per second)
 - 1. Construction: Stainless-steel body and plastic turbine or impeller, with integral direct-reading scale.
 - 2. Pressure Rating: 150 psig minimum.
 - 3. Temperature Rating: 180 deg F minimum.
 - 4. Display: Visual instantaneous rate of flow.
 - 5. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.
 - 6. Accuracy: Plus or minus 2-1/2 percent.
 - 7. Output: 4-20 mA signal.
 - 8. Performance as scheduled on drawings:
 - 9. Manufacturers: EMCO, Badger Meter, Bailey-Fischer and Porter, or approved equal.

2.19 HOT WATER BYPASS VALVE

- A. Hot water bypass valve for digester heating system shall be modulating flow control valve. Valves shall be of the non-lubricated, eccentric plug type and shall be designed for a working pressure of 175 psi. Valves shall be of round port design. Valves shall provide tight shut-off at rated pressure. The valve body shall be cast iron with a welded-in overlay of 90% nickel alloy content on all surfaces contacting the plug face. Nickel welded rings or seats screwed into the body are not acceptable. Valves shall be furnished with replaceable permanently lubricated sleeve type stainless steel or bronze bearings in the upper and lower journals.
- B. Valve shaft seals shall be self-adjusting multiple U-cup or V type, replaceable without removing the valve bonnet. "O" rings in direct contact with the plug stem not acceptable. Flanges shall have thickness as specified by ANSI standards. Valves shall be Keystone "Ballcentric" or approved equal.
- C. Electric actuator shall accept 4-20 mA control signal from chiller plant control system. Power shall be 120 volts, single phase. Provide travel limit switches where indicated. Provide visual position indicator. Actuator shall be as manufactured by Belimo or approved equal.

2.20 PRESSURE INDICATORS

- A. Pressure gauges shall be industrial general service gauges, 4-1/2" dial with stainless steel construction, isolation valve and pulsation dampener. Scale range shall be two times operating pressure. Accuracy shall be 1% of full scale. Ashcroft Type 1010 or approved equal.

2.21 TEMPERATURE INDICATORS

- A. Temperature Indicators shall be bronze case, stainless steel bulb chamber, red readings mercury tube, separable bronze well, adjustable swivel mount, 9" scale length. Scale range shall be selected to indicate operating temperature at 75 percent of full scale. Manufacturer shall be Ashcroft, Terice, or approved equal.

2.22 SHOP FINISHES

- A. Finish: ANSI 61 light gray paint.
- B. With the exception of those parts and components customarily furnished unpainted, prepare and coat all metal surfaces with rust inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified.
- C. Protect machined surfaces against damage and corrosion by other means.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

3.2 INSTALLATION

- A. Install piping, materials and equipment as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Piping Applications
 - 1. Hot Water Systems,
 - a. 2 inch and smaller: Schedule 40 steel pipe with threaded joints.

- b. 2-1/2 inch and larger: Schedule 40 steel pipe with grooved mechanical joints and flanged joints .
 2. Automatic Air Vent Drain Lines: Type 304 stainless steel tube.
- C. Valve Applications
 1. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 - a. Shutoff Duty: Ball valves or butterfly valves.
 - b. Throttling Duty: triple-duty valves, and calibrated balancing valves.
 2. Install shutoff-duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line.
 3. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.
 4. Install triple-duty valves at each pump discharge and as shown.
- D. Pipe Joint Construction
 1. Refer to Section 230500 Common Work Results for HVAC for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC piping.
- E. Piping Installation
 1. Refer to Common Work Results for HVAC for basic piping installation requirements.
 2. Support piping systems in accordance with Hangers and Supports for HVAC Piping and Equipment. Anchor and guide piping for proper direction of expansion and contraction as shown on drawings.
 3. Install drains, consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
 4. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
 5. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
 6. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, and elsewhere as indicated. Install 3/4-inch nipple and ball valve in blowdown connection of strainers 2 inches and larger. Match size of strainer blowoff connection for strainers smaller than 2 inches.
- F. Hydronic Specialties Installation
 1. Install manual air vents at heat-transfer coils, and elsewhere as required for system air venting.
 2. Install automatic air vents at high points of system piping, and at end of mains. Provide isolation valve for each automatic air vent. Discharge of automatic air vents shall be piped to floor drain.
 3. Install in-line air separators in pump suction lines. Install piping to bladder compression tank from bottom of main return line to tank per manufacturer's installation instructions. Install drain valve on units 2 inches and larger.

4. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and a ball valve in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
5. Provide straight pipe upstream and downstream of flow meters. Lengths shall be per manufacturer's recommendations.

3.3 INSULATE

- A. Insulate hydronic piping systems in accordance with Section 230700 HVAC Insulation

3.4 FLUSH AND FILL

- A. Drain entire system, including new and existing portions.
- B. Fill entire system with clean water.
- C. Circulate water for 24 hours.
- D. Drain system.
- E. Inspect and clean strainers.
- F. Fill entire system with clean water.
- G. Provide chemical treatment for hydronic piping systems in accordance with Section 232513 Water Treatment for Closed-Loop Hydronic Systems
- H. For heating systems, slowly (over the course of 1 hour, minimum) raise system temperature. Vent and purge air from hydronic system, and ensure compression tank is properly charged with air to suit system design requirements at installed or design maximum temperature.

3.5 TEST, ADJUST, AND BALANCE

- A. Test, adjust, and balance hydronic piping systems in accordance with Section 230593 Testing, Adjusting and Balancing.
- B. Include entire system, both new and existing portions.
- C. Mark calibrated nameplates of pump-discharge triple-duty valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

3.6 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.7 IDENTIFICATION

- A. Identify hydronic piping systems and components as specified in the Section "Identification for HVAC Piping and Equipment."

3.8 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.
- B. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

3.9 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 21 23
HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following categories of hydronic pumps for hydronic systems:
 - 1. In-line pumps
 - 2. Base-mounted pumps
 - 3. Pump control panel

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - 2. National Electrical Manufacturer's Association (NEMA)
 - 3. Underwriters Laboratories, Inc. (UL)

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical. Show the following:
 - 1. Vertical and horizontal runs, offsets, and transitions.
 - 2. Clearances for access above and to the side.
 - 3. Show dimensions and details, including connections.
 - 4. Support locations, type of support, and weight on each support.
 - 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
 - 1. Include certified performance curves and rated capacities; shipping, installed, and operating weights; furnished specialties; final impeller dimensions; and accessories for each type of product indicated. Indicate pump's motor efficiency and operating point on curves.

- C. Shop Drawings:
 - 1. Show pump layout and connections. Include Setting Drawings with templates for installing foundation and anchor bolts and other anchorages.
 - a. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
 - b. Submittals shall contain motor performance data, including efficiency, rated horsepower, service factor, rated speed, phase, voltage, frequency, type, frame, and insulation class.
- D. Maintenance Data: For pumps to include in maintenance manuals specified in Division 1.
- E. Closeout Submittals
 - 1. Documentation of pump exercise during storage.
 - 2. Documentation of pump commissioning,
 - 3. Operation and Maintenance Data.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Obtain signed receipt from Owner's Representative.
 - 1. For each pump: One set of all material required for pump re-build (e.g. gaskets and O-rings). Include one mechanical seal for each pump.

1.6 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter
- E. Exercise pumps in storage in accordance with manufacturer's recommendations. Document each occurrence.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. In-line Pumps:
 - a. Bell & Gossett
 - b. Taco
 - c. Or approved equal.

2.2 GENERAL PUMP REQUIREMENTS

- A. Pump Units: Factory assembled and tested.
- B. Motors:
1. All motors shall conform to reference standards outlined above. Unless otherwise specified, all motors shall be of a design suitable for full voltage starting. All motors shall operate without undue noise or vibration and shall show no signs of phase unbalance.
 2. As far as possible, all motors furnished for similar equipment shall be of one manufacturer.
 3. All motors designed for continuous operation shall be of the energy-efficient type. Energy-efficient motors shall meet requirements of NEMA Standards Publication MG-1.
 4. Select each motor to be non-overloading over full range of pump performance curve.
- C. Motor Ratings:
1. All motors shall be of the continuous rated type with adequate ratings to accelerate and drive their connected equipment under all normal operating conditions without exceeding 1.0 times the rated horsepower.
 2. All motors shall be provided with a service factor of 1.15, unless otherwise specified.
 3. Unless otherwise specified, motor synchronous speeds shall not exceed 1800 RPM.
 4. Nameplates shall be furnished with all motors with markings in accordance with NEMA standards.
- D. Mechanical Construction
1. Mechanical Protection: Unless otherwise specified, electric motors shall be of the following types of construction according to the degree of mechanical protection.
 - a. Dry Areas: Open, drip-proof.
 2. Bearings
 - a. Motors shall have bearings, of the grease lubricated, anti-friction ball type with conveniently located grease fittings. A means of preventing bearings

from becoming over greased shall be provided (such as double shields on bearings or pressure sensitive relief fittings).

- b. Where of vertical shaft construction, the motors shall have adequate thrust bearings to carry all motor loads and any other operating equipment loads.
- c. Where of horizontal shaft construction and coupled to fluid pumps, the motors shall either have adequate thrust bearings or they shall have the couplings end-play and rotor float coordinated to prevent damage to rotor bearings.

2.3 IN-LINE PUMPS

- A. Provide vertical in-line pumps, with pump characteristics that provide rising heads to shut off. Refer to pump schedule for pump flows, heads, motor speed, enclosure, efficiency and power requirements.
- B. Pump Construction
 - 1. Pump Casing: Cast iron for working pressure below 175 psig at 150°F (125 psig ANSI flange rating) and ductile iron for working pressures to 375 psig at 150°F (250 psig ANSI flange rating). Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections.
 - 2. Impeller: Bronze, fully enclosed type, dynamically balanced.
 - 3. Shaft: Provide stainless steel pump shaft.
 - 4. Coupling: Rigid spacer type of high tensile aluminum alloy couplings shall be split to allow removal from pump and motor shafts, leaving space between the shafts sufficient to replace all mechanical seal components without disturbing the pump or motor.
 - 5. Mechanical Seals: Shall be stainless steel outside multi-spring balanced type with Viton secondary seal. Provide bronze gland plate with stainless steel hardware. Provide factory installed flush line with manual vent.
 - 6. All split-coupled pumps shall be provided with a lower seal chamber throttle bushing.
 - 7. Motor horsepower shown on the schedule are minimum and have been sized for continuous operation without exceeding full load nameplate rating over the entire pump curve, exclusive of service factor.

2.4 BASE-MOUNTED PUMPS

- A. Provide based-mounted, single stage, end suction, vertical split case design, and stainless steel fitted pumps. Refer to pump schedule for pump flows, heads, motor speed, enclosure, efficiency and power requirements.
- B. Pump Construction
 - 1. Pump Casing: Pump shall be rated for minimum of 175 psi working pressure. Volute shall have gauge tappings at the suction and discharge nozzles and vent and drain tappings at the top and bottom.
 - 2. Impeller: Cast stainless steel enclosed type, balanced to ANSI/HI 9.6.4-2009 balance grade G6.3 and secured to the shaft by a locking capscrew or nut.
 - 3. Shaft: Provide stainless steel pump shaft.

4. Coupling: Flexible type, center drop-out design coupling, shall be capable of absorbing torsional vibration, shall be employed between the pump and motor. Coupling shall be shielded by a dual rated ANSI B15.1 & OSHA 1910.219 compliant coupling guard and shall have viewing windows for inspection of the coupling.
5. Mechanical Seals: The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225°F. A replaceable stainless steel shaft sleeve shall completely cover the wetted area under the seal.
6. Motor shall meet NEMA and EISA 2007 specifications and shall be of the size, voltage and enclosure shown on plans. Pump and motor shall be factory aligned, and shall be realigned by the contractor per factory recommendations after installation.
7. Baseplate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully open. The combined pump and motor baseplate shall be sufficiently stiff to limit the susceptibility of vibration. The minimum baseplate stiffness shall conform to ANSI/HI 1.3.8.2.1-2009 for grouted Horizontal Baseplate Design standards.
8. Pump shall be factory hydrostatically tested per Hydraulic Institute standards. Pump shall be manufactured, assembled and tested in an ISO 9001 approved facility.
9. Pump condition monitoring system should be provided on the pump power end to continuously measure vibration and temperature at the outboard bearing. The system shall record the baseline vibration at start-up and shall have local alarm indication at the pump when the vibration levels are double the baseline values or when alarm limits are reached for temperature and vibration.

C. Acceptable manufacturer shall be Bell & Gossett Series 1510 or approved equal.

2.5 SHOP FINISHES

- A. Finish: ANSI 61 light gray paint.
- B. With the exception of those parts and components customarily furnished unpainted, prepare and coat all metal surfaces with rust inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified.
- C. Protect machined surfaces against damage and corrosion by other means.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.
 1. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
 2. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

- B. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- C. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- D. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- E. Verify that ground connections are in place and that installation of grounding described in Electrical Sections is complete.

3.2 PUMP INSTALLATION

- A. Install pumps according to manufacturer's written instructions.
- B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so piping is not supported by pumps.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install pressure gages on pump suction and discharge. Install at integral pressure-gage tappings where provided.
- F. Install temperature and pressure-gage connector plugs in suction and discharge piping around each pump.
- G. Install electrical connections for power, controls, and devices.
- H. Electrical power and control wiring and connections are specified in Division 26 Sections.
- I. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 COMMISSIONING

- A. Verify that pumps are installed and connected according to the Contract Documents.
- B. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
- C. Perform the following preventive maintenance operations and checks before starting:
 - 1. Lubricate bearings.
 - 2. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
 - 3. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
 - 4. Verify that pumps are free to rotate by hand and that pumps for handling hot liquids are free to rotate with pumps hot and cold.
 - 5. Check suction piping connections for tightness to avoid drawing air into pumps.
 - 6. Clean strainers.
 - 7. Verify that pump controls are correct for required application
- D. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
 - 1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
 - 2. Open circulating line valves if pumps should not be operated against dead shutoff.
 - 3. Start motors.
 - 4. Open discharge valves slowly.
 - 5. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
 - 6. Check general mechanical operation of pumps and motors.
 - 7. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.
- E. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.
- F. Refer to the Section "Testing, Adjusting, and Balancing for HVAC" for detailed requirements for testing, adjusting, and balancing hydronic systems.
- G. Document all commissioning efforts.
- H. After pumping systems are commissioned, replace start-up strainers in suction diffusers with permanent strainers.

3.5 INSTALLATION

- A. Install piping, materials and equipment as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.6 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.7 IDENTIFICATION

- A. Identify piping, valves and equipment as specified in Section "Identification of HVAC Piping and equipment".

3.8 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.9 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe, fittings, valves, and specialties for refrigerant piping systems.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society of Mechanical Engineers (ASME)

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of refrigerant piping and suspension system components with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
 - 1. Vertical and horizontal runs, offsets, and transitions.
 - 2. Clearances for access above and to the side.
 - 3. Show dimensions and details, including connections.
 - 4. Support locations, type of support, and weight on each support.
 - 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 PERFORMANCE REQUIREMENTS

- A. Line test pressure for Refrigerant R-410a:
 - 1. Suction lines for air conditioning applications: 300 psig
 - 2. Hot gas and liquid lines: 535 psig.

1.5 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

- C. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications".
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components".

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
 - 5. Maximum Operating Temperature: 250 deg F (121 deg C).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.

- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section “Grounding” is complete.

3.2 INSTALLATION

- A. Install refrigerant piping according to ASHRAE 15.
- B. Install refrigerant piping in accordance with equipment manufacturer’s recommendations.
- C. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- D. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15
- E. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- F. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected.
 - 1. Thermostatic expansion valves
- G. Install piping adjacent to machines to allow service and maintenance.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. .
- K. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

3.3 INSULATE

- A. Insulate refrigerant piping systems.

3.4 SYSTEM CHARGING

- A. Charge refrigerant system in accordance with equipment manufacturer’s recommendations.

3.5 IDENTIFICATION

- A. Identify refrigerant piping systems and components as specified in the Section "Identification for HVAC Piping and Equipment."

3.6 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 25 13

WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Water Treatment Systems for Closed-Loop Hydronic Systems as shown on the Contract Drawings.

1.2 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
 - 1. Premixed glycol.
 - 2. Cleaning chemicals.
 - 3. Chemical feeders.
- C. Closeout Submittals
 - 1. Water test results.
 - 2. Monitoring documentation.
 - 3. Operation and Maintenance Data
 - 4. Warranty Documentation
 - 5. Material Safety Data Sheets for all chemicals

1.3 DELIVERY, STORAGE AND HANDLING

- A. Handle components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.4 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Chemicals: Furnish quantity equal to 20% percent of amount initially installed.

1.5 WARRANTY

- A. All equipment shall be provided with a two-year warranty on parts and labor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Drew Industrial Division, Ashland Chemical
 - 2. AquaTech
 - 3. GE Betz
 - 4. Or approved equal.

2.2 CHEMICAL FEEDING EQUIPMENT

- A. Bypass Feeders: Cast iron or steel, for introducing chemicals into system; with funnel shutoff valve on top, air-release valve on top, drain valve on bottom, and recirculating shutoff valves on sides.
 - 1. Capacity: 1.8 gal.
 - 2. Working Pressure: 125 psig.

2.3 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer recommended equipment and chemicals, in a carrying case, for testing for legionella, pH, total dissolved solids, dissolved oxygen, biocount, chloride, and total alkalinity and for calcium hardness field tests.
- B. Corrosion Test Coupon Assembly: Constructed of corrosion material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test coupon assembly.
 - 1. Two station rack for closed-loop systems.

2.4 CHEMICALS

- A. Furnish chemicals recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.
- B. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
- C. Closed-Loop, Water Piping Chemicals:
 - 1. Objectives: scale prevention, remove dissolved gases, protect against corrosion, maintain flow and heat transfer efficiency.
 - 2. Chemicals shall include:
 - a. Sequestering agent to reduce deposits and adjust pH
 - b. Corrosion inhibitors
 - c. Conductivity enhancers

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.
- B. Perform tests and report results and correctly balance system.
- C. Instruct Owner's personnel in system maintenance and operation.
- D. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.2 CHEMICAL SYSTEM CLEANING

- A. Each closed loop heat transfer system shall be chemically cleaned, to remove impurities from system.
- B. The system cleaner shall be INTERCLEAN MC-1 or approved equal.
- C. Contractor shall be responsible for proper disposal of cleaning water after cleaning is complete.

3.3 FOLLOW-UP SERVICE

- A. Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, perform the following monitoring and adjusting tasks:
 - 1. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
 - 2. Report: Prepare a written report covering monitoring performed and corrective action taken.

END OF SECTION

SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ductwork systems as shown on the Contract Drawings.

1.2 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
1. American Society for Testing and Materials (ASTM)
 2. Underwriters Laboratories (UL)
 3. National Fire Protection Association (NFPA)
 4. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
1. Vertical and horizontal runs, offsets, and transitions.
 2. Clearances for access above and to the side.
 3. Show dimensions and details, including connections.
 4. Support locations, type of support, and weight on each support.
 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. In addition to those submittals identified in the General Conditions, the following shall be submitted:
1. Layout drawings of the equipment, ductwork, hangers, supports and accessories. Coordinate layout drawings with architectural, structural, electrical, plumbing, and mechanical work. Drawings shall list ductwork material, thickness (gauge), seam types, seam dimensions, and seal class for each size or size range of duct.

2. Method of attachment of duct hangers to building construction.
- C. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1.5 QUALITY ASSURANCE

- A. Qualifications
 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Ductwork
 1. Galvanized Steel: ASTM A924 and ASTM A653.
 2. Aluminum: ASTM B209, Alloy 3003, Temper H-14
 3. Stainless Steel - ASTM A480, Type 316
- B. Duct Hangers
 1. Strap Hangers: Same material as ducts.
 2. Rod Type Hangers: Stainless steel unless otherwise specified, fully threaded or threaded each end, with two removable stainless steel nuts each end for positioning and locking rod in place.
- C. Miscellaneous Fasteners and Upper Hanger Attachments
 1. Sheet Metal Screws, Machine Bolts and Nuts: Same material as duct, unless otherwise specified.
 2. Concrete Inserts: Steel or malleable iron, galvanized; continuously slotted or individual inserts.
 3. Welding Studs: Erico Fastening Systems, capacitor discharge, low carbon steel, copper flashed.
 4. Structural (carbon) Steel Shapes and Steel Plates: ASTM A36, shop primed.
 5. Machine Bolt Expansion Anchors:
 - a. Non-caulking single unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 1.
 - b. Non-caulking double unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 2.
 - c. Self-drilling type: FS FF-S-325, Group III, Types 1 and 2.

2.2 DUCT SEALANT

- A. Low and medium pressure supply, exhaust and outdoor air duct systems shall be provided with Class A seals as defined in the SMACNA duct construction standards and as noted

herein. All joints and connections shall be sealed with Duro-Dyne S-2 Hi-Pressure Sealer (an oil resistant polymer solution) or equal. Apply sealer to clean duct surface. For medium pressure classes 2 inches through 10 inches w.g., apply a 2-inch wide strip of polyvinyl-treated open weave fiberglass membrane over the wet sealer, then apply another coat of sealer over the membrane, as per manufacturer's recommendation. In addition, Contractor shall apply a coat of sealant to all male connectors of round ducts with medium pressure classification.

- B. Low pressure return systems only need to meet Class C sealing requirements.
- C. Ductmate connections do not have to be sealed if installed per manufacturer's recommendations (see Part 3 – Execution).

2.3 FLEXIBLE DUCT

- A. Insulated flexible duct shall be a factory-fabricated assembly consisting of an inner sleeve, insulation and an outer moisture barrier. The inner sleeve shall be constructed of a continuous vinyl-coated spring steel wire helix bonded to a continuous layer of vinyl-coated fiberglass mesh. A thick insulating blanket of fiberglass, providing a thermal conductance (C Factor) of 0.23 BTU/hr/ft²/deg F at 75 deg F, shall encase the inner sleeve and be sheathed with an outer moisture barrier of a reinforced metalized Mylar/neoprene laminate of low permeability with integral attaching devices (grommets) for a suspension system as listed by Underwriters' Laboratories, Inc. The flexible duct shall be rated for a maximum working velocity of 2500 FPM and a maximum working pressure of 6 inches w.g. positive and 2 inches w.g. negative, and shall be listed by Underwriters' Laboratories, Inc. under its UL-181 Standard as a Class 1 air duct and shall comply with NFPA Standard No. 90A. The flexible duct shall be Thermaflex MK-E as manufactured by Flexible Tubing Division, or similar by Automation Industries, Inc., United McGill, Flexaust Co., or approved substitution.

2.4 DUCT LINER

- A. Fibrous glass duct liner, conforming to ASTM C1071, Type I, flexible. Liner shall also conform to NFPA 90A, and ASHRAE 62.
- B. Erosion rating shall be a minimum of 5000 fpm.
- C. Apply in 1" thickness.
- D. Owens Corning QuietR, or approved equal.

PART 3 - EXECUTION

3.1 DUCT CONSTRUCTION

- A. Construct ductwork in accordance with SMACNA Standards, as follows;
 - 1. For ductwork in the Administration Building, construct duct in accordance with SMACNA *HVAC Duct Construction Standards, Metal and Flexible*.

2. For the remainder of the Plant, construct duct in accordance with SMACNA *Rectangular Industrial Duct Construction Standards*, and SMACNA *Round Industrial Duct Construction Standards*.

3.2 DUCTWORK APPLICATION SCHEDULE

Air System	Pressure Classification	Material
Outside Air	2" wc	Stainless Steel
Fine Screen Building Ventilation	4" wc	Stainless Steel
Plant Effluent Pump Station (PEPS) Building Ventilation	2" wc	Stainless Steel
Boiler Room Ventilation – supply, return, and exhaust	2" wc	Stainless Steel
Vestibule Pressurization	2" wc	Stainless Steel
Secondary Gallery Ventilation	2" wc	Stainless Steel
Primary Sludge Pumping Station 1 Ventilation	2" wc	Stainless Steel
Administration Building Air Conditioning – outside air	4" wc	Stainless Steel
Administration Building Air Conditioning – supply, return	4" wc	Galvanized Steel
Laboratory Air Conditioning – supply, return	4" wc	Stainless Steel

3.3 GENERAL

- A. Duct sizes shown on drawings are in terms of width by depth. Duct sizes are inside clear dimensions.
- B. Provide flexible connectors at connections to fans, air handling equipment, and fume hoods.
- C. All square-corner elbows and all short-radius elbows where the center line radius is less than 1-1/2 times duct width shall be fitted with directional flow air-turning vanes on supply, return, intake and exhaust systems.
- D. Exhaust duct branch connections shall be made at 45 degrees.
- E. Maintain duct cross-sectional area at offsets.
- F. Ductwork shall not be penetrated by obstructions such as pipe or conduit.

3.4 INSTALLATION

- A. Install interior ductwork as high as possible and parallel to walls.

- B. Ductwork shall not be installed in front of doors or windows. Ductwork shall not block access to equipment
- C. Install products in accordance with the manufacturer's instructions.
- D. Check locations of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and light arrangement.
- E. Install duct-mounted diffusers and registers with air-tight connection.
- F. Provide volume dampers on duct take-off to diffusers, registers, and grilles.
- G. Paint ductwork visible behind air outlets and inlets with matte black.

3.5 EXTERIOR FINISH

- A. Attach sponge rubber padding to exterior corners of horizontal ductwork less than 7 feet 0 inches above finished floor.

3.6 CLEANING

- A. Clean dust, dirt, debris, and scrap metal from inside ductwork prior to start-up.

3.7 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Electrical Sections is complete.

3.8 IDENTIFICATION

- A. Identify as specified in Section "Identification for HVAC Piping and Equipment".

3.9 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

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3.10 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Ductwork Accessories as shown on the Contract Drawings.

1.2 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein.
1. Underwriters Laboratories (UL).
 2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).
 3. International Energy Conservation Code.
 4. International Mechanical Code.

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
1. Vertical and horizontal runs, offsets, and transitions.
 2. Clearances for access above and to the side.
 3. Show dimensions and details, including connections.
 4. Support locations, type of support, and weight on each support.
 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following shall be submitted:
1. Layout drawings of the equipment, duct work, hangers, supports and accessories. Coordinate layout drawings with architectural, structural, electrical, plumbing, and mechanical work. Drawings shall specify duct work material, pressure classifications, thickness (gauge), seam types, seam dimensions, and seal class for each size or size range of duct.
 2. Details of intermediate structural steel members required to span main structural steel for the support of duct work.
 3. Method of attachment of duct hangers to building construction.
 4. Installation details for each type of fire damper used.

- B. Submit the following in accordance with the General Conditions.
- C. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1.5 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

PART 2 - PRODUCTS

2.1 FILTERS AND HOUSINGS

- A. Air filters shall be MERV 8, Camfill Farr 30/30, or equal.
- B. Housing shall provide for slide in access to filter with gasketed hinged access door. Material of construction shall match the ductwork system.

2.2 FIRE DAMPERS

- A. Fire dampers shall be interlocking-blade, curtain-type, and 165 deg F fusible link. Dampers shall be suitable for mounting in either a vertical or horizontal position as shown on the Contract Drawings.
- B. Fire dampers shall be rated for 1-1/2 hours as shown on the Contract Drawings. Rating shall be in accordance with UL 555, and each damper shall be UL-listed.
- C. Style B fire dampers shall be used on ducts smaller than or equal to 12-inch x 12-inch or 12-inch diameter. Style B fire dampers shall be rated for 1-1/2 hours.
- D. Style A fire dampers shall be used on ducts greater than 12-inch x 12-inch or 12-inch diameter. Style A fire dampers shall be rated for 1-1/2 hours.
- E. Interior Fire Dampers
 - 1. Style WC fire dampers shall be rated for 1-1/2 hours.
- F. Manufacturers:
 - 1. Ruskin
 - 2. NCA Manufacturing
 - 3. Equal

2.3 VOLUME DAMPER

- A. Rectangular volume dampers material to match duct, manual operator, locking quadrant, opposed action blades.

- B. Round volume dampers material to match duct, manual operator, locking quadrant, single blade.
- C. Manufacturers:
 - 1. Ruskin
 - 2. NCA Manufacturing
 - 3. Equal

2.4 CONTROL DAMPERS

- A. Material shall match duct.
- B. Stainless Steel
 - 1. Rectangular control dampers shall be 14-gauge stainless steel; air foil section, opposed action blades and suitable for use with an electric actuator. Damper shall be provided with head, sill, blade, and jamb seals. AMCA Standard 500 tested leakage rate of 48-inch x 48-inch damper shall be less than 5.6 cfm per sq ft at 4 inches w.g. Static pressure drop shall be less than 0.03-inch water-column at free area velocity of 1000 fpm. .
 - 2. Round control dampers shall be galvanized or stainless steel, single blade, pressure-sensitive blade seal and suitable for use with an electric actuator. Maximum leakage rate shall be 4 cfm per sq ft at 4 inches w.g
 - 3. Electric actuator shall be provided by damper manufacturer. Actuator operating cycle and voltage shall be 60hertz, 120 volts.

2.5 BACKDRAFT DAMPERS

- A. Gravity-operated dampers shall be aluminum to match duct with blade seals and weighted operator. Damper shall start to open a 0.1" wc pressure, and be fully open at 0.15" wc pressure.
- B. Frame shall be 0.90" thick extruded aluminum. Blades shall be 0.25" thick aluminum, with vinyl edge seals. Blade edge seals shall be mechanically locked into blade edge. Bearings shall be corrosion resistant synthetic, and linkage shall be concealed in frame.
- C. Ruskin BD2/A2 or approved equal.

2.6 FLEXIBLE CONNECTORS

- A. Flexible duct connector shall be fiberglass fabric coated with neoprene. Weight: 30 oz/sq yd. Thickness: 0.024 inches.

2.7 LOW-PROFILE VARIABLE-AIR-VOLUME BOX

- A. Basis-of-Design Product:
 - 1. Price
 - 2. Or approved equal
- B. Provide factory assembled, low-profile, variable air volume control terminals. Units shall be complete with a damper assembly, flow sensor, electric heating coil, collars for duct

connection, and all required features. The DDC contractor shall provide and install VAV controllers and actuators.

- C. Cabinet shall be constructed of 22 gauge galvanized steel with round, rectangular or flat oval inlet collar and rectangular discharge with slip and drive connection. Acoustical/thermal liner shall be ½-inch thick, 1.5 pound per cubic foot density insulation meeting the requirements of NFPA 90A and UL181. All exposed edges of insulation shall be coated with an approved sealant to prevent erosion
- D. The damper assembly shall be made of extruded aluminum located in a 16 gauge damper frame, utilizing steel damper linkages and mounted on nylon self-lubricating blade bearings. Dampers shall have an open cell foam damper seal affixed to the blade, providing a maximum of 2% of the maximum rated capacity with an inlet pressure of 3 in. wg.
- E. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Electric heating coil shall include:
 - 1. Electronic modulating controls.
 - 2. Door interlock disconnect switch.
 - 3. Access door interlocked disconnect switch. Field verify location of access door.
 - 4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
 - 5. Nickel chrome 80/20 heating elements.
 - 6. Airflow switch for proof of airflow.
 - 7. Fan interlock contacts.
 - 8. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 - 9. Pneumatic-electric switches and relays.
 - 10. Insulated heater section.
- F. Direct Digital Controls: Microprocessor-based controller, bidirectional damper operators, electric heat controller, and room sensor. Control devices shall be compatible with temperature controls specified in Section 23 09 23 "Direct Digital Control System for HVAC" and shall have the following features:
 - 1. Damper Actuator: 24 V, powered closed, power open.
 - 2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - a. Occupied and unoccupied operating mode
 - b. Remote reset of airflow or temperature set points
 - c. Adjusting and monitoring with portable terminal
 - d. Communication with temperature-control system specified in Section 23 09 23 "Direct Digital Control System for HVAC".
 - 3. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

2.8 ACCESS DOORS

- A. Access doors shall be galvanized steel, stainless steel, or aluminum to match duct with insulated, double wall construction.
- B. Provide butt or piano type hinges and SMACNA Lock Type 1 sash locks.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide flexible connectors at connections to fans, air handling equipment, and fume hoods.
- B. Provide access doors at inlet side of coils, intake plenums, and fire dampers.

3.2 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Adjust location of VAV boxes to suit field conditions. Provide clearance for maintenance.
- C. Insulate VAV boxes to match adjacent ductwork.

3.4 IDENTIFICATION

- A. Identify as specified in Section "Identification for HVAC Piping and Equipment."

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth.

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Touch up exposed surfaces to match original finish. Vacuum interior “white glove clean”, removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.6 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Fans and associated equipment as shown on the Contract Drawings.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. Air Moving and Conditioning Association (AMCA).
 - 2. American Society Of Testing Materials (ASTM).
 - 3. National Electrical manufacturers Association (NEMA).

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
 - 1. Vertical and horizontal runs, offsets, and transitions.
 - 2. Clearances for access above and to the side.
 - 3. Show dimensions and details, including connections.
 - 4. Support locations, type of support, and weight on each support.
 - 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- C. Shop Drawings:
 - 1. Fan curves with operating point clearly marked.
 - 2. Sound data.
 - 3. Motor orientation.

- D. Closeout Submittals
 - 1. Operation and Maintenance Data.

1.5 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Coordinate delivery to allow movement into designated space.

PART 2 - PRODUCTS

2.1 IN-LINE FAN

- A. Manufacturers:
 - 1. Loren Cook
 - 2. Greenheck
 - 3. Or approved equal
- B. Description: All-aluminum, in-line mixed-flow fans shall be the sizes and capacities as shown on the drawings. Fans shall be belt or direct driven as scheduled.
- C. Materials and Construction:
 - 1. Fan Housing
 - a. Fan housing shall be constructed of minimum 0.125-inch-thick marine-alloy aluminum with inlet and discharge flanges. Provide one access door and mounting feet.
 - 2. Fan Wheels
 - a. Fan wheels shall be backward inclined, centrifugal type of aluminum construction. Wheel and shaft shall be statically and dynamically balanced at the factory, in accordance with AMCA standard 204-96.
 - 3. Shafts
 - a. Fan shafts shall be ground and polished steel sized so that the first critical speed is at least 25% over the maximum operating speed. Pillow block bearings shall be factory-tested and designed for air handling applications with a minimum (L50) life in excess of 200,000 hours.
 - 4. Motors
 - a. Motors for belt drive shall be premium efficiency type and shall be matched to the fan load horsepower as indicated.
 - b. Motors for direct drive non-hazardous (non-explosion proof) shall be electrically commutated motors with integral speed adjusters accessible by screw driver.
 - c. Motors for hazardous explosion proof areas shall be XP rated for Class I, Division 1, group D.

5. Drives
 - a. Drives shall be sized for 150% of driven horse power. Machined cast iron pulleys shall be factory-set to the required speed (rpm) and shall be field adjustable for final system balancing. Provide extended lube lines.
6. Disconnect Switch
 - a. Provide factory-mounted and -wired, NEMA 1 disconnect switch.
 - b. Provide factory-mounted and -wired, NEMA 7 explosion-proof disconnect switch for hazardous areas (Class I, Division 1, Group D).
7. Motor Cover/Belt Guard
 - a. Provide aluminum constructed, combination motor cover and belt guard.
8. Provide vibration isolators and flexible connectors.
9. Damper
 - a. Provide factory-matched manually-operated inlet vane damper on fan inlet as scheduled.

2.2 WALL EXHAUSTER

- A. Manufacturers:
 1. Loren Cook
 2. Greenheck
 3. Or approved equal
- B. Materials and Construction: Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The spun aluminum wall flange shall have pre-punched keyslot holes and a mounting template with wall opening location for ease of installation. The windband shall have a rolled bead for added strength. A two piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design airflow (cfm), static pressure and maximum fan speed (rpm). Unit shall be shipped in ISTA Certified Transit Tested Packaging. Units serving classified spaces shall be suitable for Class I, Division 1
- C. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.
- D. Motor: Motors as scheduled.
- E. Drive: Belt drive units shall include automatic belt tensioner. Direct-drive units shall include speed controller. Bearings shall include extended lube lines.
- F. Disconnect: Provide factory-mounted and wired disconnect switch.

- G. Dampers: Provide damper as scheduled.

2.3 ROOF-MOUNTED SUPPLY FAN

A. Manufacturers:

1. Loren Cook
2. Greenheck
3. Or approved equal

B. Materials and Construction:

1. Fan shall be a roof-mounted, belt-driven, cast aluminum propeller, reversible exhaust and supply ventilator with aluminum top cap.
2. Construction: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners. The motor, bearings, and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators.
3. Propeller: The propeller shall be reversible, cast aluminum airfoil design with cast aluminum hub. The blade pitch shall be factory set and locked using set screws and roll pin. The hub shall be keyed and locked to the shaft utilizing two setscrews or a taper lock bushing. Propeller shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
4. Motor: Motor shall be heavy-duty type with permanently lubricated sealed ball bearings.
5. Bearings: Bearings shall be designed and individually tested for use in air handling applications. Construction shall be heavy-duty re-greasable ball type in a cast iron housing, selected for a minimum L50 life in excess of 200,000 hours at maximum operating speed. Bearings shall include extended lube lines.
6. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive shall be factory set to the specified fan speed (rpm).
7. Fan shall be provided with a reversing switch, which shall be set to the supply mode.
8. Units serving classified spaces shall be suitable for Class I, Division 1, Group D applications.
9. Provide corrosion resistant coating on all non-aluminum parts. Coating shall be suitable for gases and vapors found in municipal wastewater treatment plants. Coating shall be Heresite or equal.
10. Fan air intake shall be provided with aluminum bird screen.
11. Provide fan with a factory-mounted and wired disconnect switch.
12. Dampers: provide dampers for mounting in roof curb, as noted in schedule.
13. Roof Curb: provide fan with insulated roof curb. Field verify existing roof arrangement, including pitch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

3.2 INSTALLATION

- A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Roof fans and intake hoods shall be installed with a rubber gasket between the unit's base and the roof curb. The curb cap shall be securely mounted to the roof curb.
- C. Vibration Isolators for fans shall be internally isolated by the manufacturer.
- D. Roof Curbs: Top of curb shall set level. Provide sloping roof curb or shims as required.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Engage a factory-authorized service representative to perform the following inspections, checks, and supervision of testing:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with the manufacturer's installation recommendations and requirements.
 - 2. Set field-adjustable settings to the values recommended by the equipment manufacturer.
 - 3. Confirm vibration is within allowable limits.

3.4 PAINTING

- A. Perform field painting in accordance with the Section "Painting."

3.5 IDENTIFICATION

- A. Identify as specified in the Section "Identification For HVAC Piping and Equipment".

3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior “white glove clean”, removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.7 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes air outlets and inlets and louvers as shown on the Contract Drawings.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. National Fire Protection Association (NFPA)
 - 2. Underwriters Laboratories (UL)
 - a. Fire Resistance Directory

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of Air Outlets and Inlets with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

1.4 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- C. Shop Drawings: Shop drawings shall indicate assembly, noise criteria, flow criteria, pressure drop, unit dimensions, required clearances, construction details, and field connection details.
- D. Manufacturer Instructions: Submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Store Air inlets and Outlets in clean dry indoor rooms with electric heating to maintain the storeroom between 5 and 40 deg. C. Comply with manufacturer's additional written instructions for storing and periodic inspection and testing.

- B. Handle Air Outlets and Inlets components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.7 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 DIFFUSER D-1

- A. Square diffuser designed for VAV applications, with 360-degree air delivery pattern.
- B. Aluminum construction, with white baked-on finish.
- C. Designed to mount in lay-in tee-bar ceiling, with 24" x 24" face.
- D. Air shall be diffused through multiple die-stamped cones. Diffusion pattern shall be adjustable.
- E. Neck size as noted on drawings. Maximum pressure drop shall be 0.1" wc.
- F. Provide with balancing damper.
- G. Anemostat model EPLA or approved equal.

2.2 TRANSFER GRILLE

- A. Manufacturers: Titus Model 300FL, or approved equal by Anemostat or Krueger.
- B. Description:
 - 1. Double Deflection. Front blades shall be horizontal with individually adjustable tapered blades spaced 3/4 inch apart. Rear blades shall be individually adjustable tapered blades spaced 3/4 inch apart.
 - 2. All necessary appurtenances shall be provided to allow for mounting.
 - 3. Register blades shall have a 1-3/8 inch margin frame with countersunk screw mounting.
 - 4. Unless otherwise indicated, register blades and frame shall have factory-applied white finish.
 - 5. All supply registers shall be constructed with radius end caps and foam gaskets for a tight seal to the duct diameter.

2.3 SUPPLY REGISTER

- A. Manufacturers: Titus Model 300FL/300RL, or approved equal by Anemostat or Krueger.
- B. Supply register shall be aluminum or steel to match the ductwork of the respective system.
- C. Description:

1. Double Deflection. Front blades shall be horizontal with individually adjustable tapered blades spaced 3/4 inch apart. Rear blades shall be individually adjustable tapered blades spaced 3/4 inch apart.
2. Register shall have integral; face adjustable, opposed blade damper constructed of heavy duty extruded aluminum.
3. All necessary appurtenances shall be provided to allow for mounting.
4. Register blades shall have a 1-3/8 inch margin frame with countersunk screw mounting.
5. Unless otherwise indicated, register blades and frame shall have factory-applied white finish.
6. All supply registers shall be constructed with radius end caps and foam gaskets for a tight seal to the duct diameter.

2.4 RETURN REGISTER

- A. Heavy extruded aluminum frame shall have countersunk screw mounting. Unless otherwise indicated, register blades and frame shall have factory-applied white finish.
- B. Register shall be suitable for 24"x24" ceiling mounting as shown on the Contract Drawings. All necessary appurtenances shall be provided to allow for mounting.
- C. Actual sizes and airflows from individual registers shall be as indicated on plans.
- D. Register shall have integral, face adjustable, opposed blade damper constructed of 20-gauge galvanized steel.
- E. Manufacturers: Titus Model 50F, or approved equal by Anemostat or Krueger.

2.5 EXHAUST REGISTER

- A. Return register shall be aluminum or steel to match the ductwork of the respective system.
- B. 1/2 inch spacing of angled blades.
- C. Heavy extruded frame shall have countersunk screw mounting. Unless otherwise indicated, register blades and frame shall have factory-applied white finish.
- D. All necessary appurtenances shall be provided to allow for mounting.
- E. Actual sizes and airflows from individual registers shall be as indicated on plans.
- F. Register shall have integral, face adjustable, opposed blade damper constructed of 20-gauge galvanized steel.
- G. Manufacturers: Titus Model 355FL/355RL, or approved equal by Anemostat or Krueger.

2.6 EXHAUST GRILLE

- A. Return grille shall be aluminum or steel to match the ductwork of the respective system.
- B. 1/2 inch spacing of angled blades.

- C. Heavy extruded frame shall have countersunk screw mounting. Unless otherwise indicated, register blades and frame shall have factory-applied white finish.
- D. All necessary appurtenances shall be provided to allow for mounting.
- E. Actual sizes and airflows from individual registers shall be as indicated on plans.
- F. Register shall have integral, face adjustable, opposed blade damper constructed of 20-gauge galvanized steel.
- G. Manufacturers: Titus Model 355FL/355RL, or approved equal by Anemostat or Krueger.

2.7 LOUVERS

- A. Extruded aluminum stationary or combination louvers with drainable blades.
- B. Performance Ratings: AMCA licensed
- C. Construction:
 - 1. Frame:
 - a. Material: Extruded aluminum, Alloy 6063-T5.
 - b. Wall Thickness: 0.081 inch (2.1 mm), nominal.
 - c. Depth: 6 inches (152 mm).
 - d. Downspouts and caulking surfaces.
 - 2. Blades:
 - a. Style: Drainable.
 - b. Material: Extruded aluminum, Alloy 6063-T5.
 - c. Wall Thickness: 0.081 inch (2.1 mm), nominal.
 - d. Angle: 37.5 degrees.
 - e. Centers: 5-29/32 inches (150 mm), nominal.
 - 3. Bird Screen:
 - f. Material: Aluminum, 1/2 inch mesh x 0.063 inch, intercrimp.
 - g. Frame: Removable, rewireable.
 - 4. Gutters: Drain gutter in head frame and each blade.
 - 5. Downspouts: Downspouts in jambs to drain water from louver for minimum water cascade from blade to blade.
 - 6. Vertical Supports: Hidden vertical supports to allow continuous line appearance up to 120 inches (3,048 mm).
 - 7. Sill: Steeply angled integral sill eliminating areas of standing or trapped moisture where mold or mildew may thrive and effect indoor air quality.
 - 8. Assembly: Factory assembled louver components. All welded construction.
- D. Design Load: Incorporate structural supports required to withstand wind load of 20 pounds per square foot.
- E. Extended Sills: Extruded aluminum, Alloy 6063-T5. Minimum nominal wall thickness 0.060 inch (1.5 mm).
- F. Non Visible Mullions: Manufacturer's standard horizontal or vertical mullions for architectural accent as indicated on drawings.

- G. Combination louver shall include adjustable blades behind stationary blades. Blade and jamb seals shall provide tight closure. Concealed blade linkage shall be protected from weather exposure. Electric actuator shall be Belimo or approved equal. Actuator shall be provided with limit switches where noted.
- H. Kynar 500 Fluoropolymer Coating:
 - 1. Conform to AAMA 605.2.
 - 2. Apply coating following cleaning and pretreatment.
 - 3. Cleaning: AA-C12C42R1X.
 - 4. Dry louvers before final finish application.
 - 5. Total Dry Film Thickness: Approximately 1.2 mils, when baked at 450 degrees F for 10 minutes.
 - 6. Submit full color range for Architect's color selection
- I. Stationary louver shall be AMCA rated model ELF6375DX as manufactured by Ruskin, or equal by Construction Specialties or Greenheck. Combination louver shall be AMCA rated model ELC6375DAX as manufactured by Ruskin, or approved equal by Construction Specialties or Greenheck

2.8 DRUM LOUVERS

- A. Outer borders shall be 1¼ inches wide and shall be constructed of heavy gauge extruded aluminum.
- B. Drum shall be constructed of heavy gauge extruded aluminum and shall rotate a minimum of 25° up and down from center line of the diffuser. Heavy extruded aluminum blades shall be individually adjustable.
- C. Actual sizes and airflows from individual registers shall be as indicated on plans.
- D. Opposed-blade volume damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the grille.
- E. Finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.
- F. Manufacturers: Titus Model DL, or approved equal by Anemostat or Krueger.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide supply and return air registers with 45° entries that are 4 inches long. Install registers with duct extensions such that no part of the register protrudes into the 45° entry.

3.2 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- C. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

3.3 INSTALLATION

- A. Install products in accordance with the manufacturer's instructions.
- B. Check locations of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and light arrangement.
- C. Install duct mounted diffusers and registers with air-tight connection.
- D. Provide volume dampers on duct take-off to diffusers, registers, and grilles.
- E. Paint ductwork visible behind air outlets and inlets with matte black.
- F. Install Air Inlets and Outlets as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- G. Provide testing adjusting and balancing in accordance with the Section "Testing, Adjusting and Balancing for HVAC."

3.4 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish.

3.5 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 51 00

BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Insulated Positive Pressure Chimney.
- B. Corrosion Resistant Positive Pressure Chimney.

1.2 RELATED SECTIONS

- A. General Provisions.
- B. General Specifications.
- C. Section 23 52 33 – Flexible Tube Boilers
- D. Section 23 52 16 – Non-Condensing Boilers
- E. Section 42 67 26 – Plant Maintenance Washing Equipment.

1.3 REFERENCES

- A. International Fuel Gas Code
- B. American Gas Association (AGA):
 - 1. AGA Directory of Certified Appliances and Accessories.
- C. National Fire Protection Association (NFPA):
 - 1. NFPA 54 – National Fuel Gas Code
 - 2. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
- D. Underwriters Laboratories
 - 1. UL-103 – Standard for Chimneys, Factory-Built, Residential Type and Building Heating Appliance.

1.4 SUBMITTALS

- A. General Provisions and General Specifications - Procedures for submittals.
- B. Shop Drawings - Indicate general assembly, components, sizing calculations, installation drawings and instructions.
- C. Product Data - Provide data indicating general assembly, components, and materials of construction.
- D. General Provisions and General Specifications - Submittals for information.

- E. Submit manufacturer's installation instructions: Indicate assembly, support details, connection requirements.
- F. Operation and Maintenance Data - Include manufacturer's descriptive literature, inspection and cleaning procedures, replacement parts list, and maintenance and repair data. Provide in accordance with the General Provisions and General Specifications.

1.5 QUALITY ASSURANCE

- A. Manufacturer - Company specializing in manufacturing the Products specified in this section with minimum 10 years' documented experience.
- B. Installer - Company specializing in installing and servicing the products of this section with minimum five years' documented experience approved by manufacturer.

1.6 REGULATORY REQUIREMENTS

- A. Conform to state and local code requirements.
- B. Chimney products to be UL listed for the service intended.
- C. Conform to applicable NFPA code requirements.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. General Provisions and General Specifications - Transport, handle, store, and protect products.
- B. Protect chimney components from damage until final installation.

PART 2 - PRODUCTS

2.1 INSULATED POSITIVE PRESSURE CHIMNEY

- A. Manufacturers:
 - 1. Metal-Fab IPIC-2, or approved equal by Ampco, Selkirk, or Van Packer
- B. All chimney supports, roof penetrations, terminations, appliance adapters, drain fittings and expansion joints required to install the chimney shall be included.
- C. Roof penetration pieces shall be UL-listed products of the chimney manufacturer. Each termination shall be provided with raincap.
- D. The chimney shall be of the double-wall, factory-built type for use with equipment burning gaseous, liquid or solid fuels as described in NFPA-211, which produce flue gases exhausted at a temperature not exceeding 1400 deg F continuously and 1800 deg F intermittently. All metallic components shall be stainless steel.
- E. Chimney shall be listed for an internal static pressure of 60 inches w.g.
- F. The stack and breeching sections shall be constructed of an inner and an outer wall with ceramic fiber insulation between the walls.

- G. The inner wall shall be constructed of Type 316 stainless steel, 0.035-inch thickness for diameter 6 inches through 36 inches, and 0.048-inch thickness for diameter 38 inches through 48 inches.
- H. The outer wall shall be constructed of Type 316 stainless steel, 0.024-inch thickness for all sizes.
- I. Inner and outer walls shall be connected by means of spacer clips that maintain the concentricity of the annular space and allow unobstructed differential thermal expansion of inner and outer walls
- J. The chimney shall include a 2-inch thickness of ceramic fiber insulation between the inner and outer walls.
- K. All inner pipe joints shall be held together by means of formed vee bands and sealed with P077 Silicone Sealant for flue gas temperatures up to 600 deg F, or P071 High Temperature Sealant for flue gas temperatures over 600 deg F.
- L. Where exposed to weather, the outer closure band shall be sealed with the same sealant as the inner joint to prevent rainwater from entering the space between the inner and outer walls.
- M. Stainless steel nuts for the inner and outer bands shall be retained by means of a free-floating cage to allow easy alignment.
- N. Stainless steel screws shall be of the hex head type with shoulder stops and tapered "lead-in" threads for easy starting.

2.2 CORROSION RESISTANT POSITIVE PRESSURE CHIMNEY

- A. Manufacturers:
 - 1. Chimney shall be Corr/Guard Model CG, as manufactured by Metal-Fab, Inc., or approved equal by Ampco, Selkirk, or Van Packer
- B. All chimney supports, roof penetrations, terminations, appliance adapters, drain fittings and expansion joints required to install the chimney shall be included.
- C. Roof penetration pieces shall be UL-listed products of the chimney manufacturer. Each termination shall be provided with raincap.
- D. The vent shall be double-wall, factory-built type, for use on condensing appliances or pressurized venting systems serving Category II, III, or IV appliances
- E. Maximum temperature shall not exceed 550F.
- F. Chimney shall be listed for an internal static pressure of 10 inches w.g.
- G. The stack and breeching sections shall be constructed of an inner and an outer wall with a 1" annular air space between the walls. All metallic components shall be stainless steel.
- H. The inner wall shall be constructed of AL29-4C® superferritic stainless steel, 0.015-inch thick.

- I. The outer wall shall be constructed of Type 430 stainless steel, 0.012-inch thickness for all sizes.
- J. Inner and outer walls shall be connected by means of spacer clips that maintain the concentricity of the annular space and allow unobstructed differential thermal expansion of inner and outer walls
- K. Vent shall be secured by stainless steel sheet metal screws through casings. Joints shall be sealed with factory installed gaskets. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with the International Fuel Gas Code.
- C. Each vent system shall be in accordance with the appliance vendor's recommendations, and the following:
 - 1. Flexible water tube boilers shall be provided with insulated positive pressure chimney.
 - 2. Plant maintenance washing equipment shall be provided with corrosion-resistant positive pressure chimney.
- D. Chimneys shall terminate at least 5 feet above the roof, or as required by local codes.
- E. Support chimney from building structure using hanger rod and epoxy grouted anchors. Use of hanger strap not permitted. Dampers shall be supported independently from the chimney sections. Support devices and components shall be constructed from stainless steel.

END OF SECTION

SECTION 23 52 33

FLEXIBLE WATERTUBE BOILERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged flexible watertube boilers, burners, trim, and accessories for generating hot water.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society of Mechanical Engineers (ASME)
 - a. ASME Heating Boiler Code, Section IV.
 - b. CSD-1, ASME standard Controls and Safety Devices for Automatically Fired Boilers.
 - 2. Underwriters Laboratories (UL).
 - 3. Factory Mutual (FM).
 - 4. National Fire Protection Association (NFPA)
 - a. NFPA 54, National Fuel Gas Code.
 - b. NFPA 70, National Electrical Code.
 - c. NFPA 85, Boiler and Combustion Systems Hazards Code.
 - 5. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: Manufacturer's data sheets, marked to specifically indicate the equipment and materials proposed for this project, and demonstrate compliance with specifications. Indicate selections with arrows, and cross out irrelevant data. Include performance data, operating characteristics, furnished specialties, and accessories
- C. Shop Drawings: for boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work. Include wiring diagrams for power, signal, and control wiring.
- D. Closeout Submittals
 - 1. Operation and Maintenance Data.
 - 2. Warranty Documentation
 - 3. Provide a copy of all test reports and start-up documentation to Owner.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Fabricate and label boilers to comply with the ASME Boiler and Pressure Vessel Code.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the authorities having jurisdiction, and marked for intended use.
- C. ASHRAE 90.1 Compliance: Boilers shall have minimum efficiency in accordance with ASHRAE 90.1.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver in shipping splits that can be moved past obstructions in the delivery path.
- B. Coordinate delivery to allow movement into designated space.
- C. Handle components according to manufacturer's written instructions. Use factory-provided lifting provisions.

1.6 COORDINATION

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
 - 1. Vertical and horizontal runs, offsets, and transitions.
 - 2. Clearances for access above and to the side.
 - 3. Show dimensions and details, including connections.
 - 4. Support locations, type of support, and weight on each support.
 - 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.
- C. Coordinate size and location of concrete bases.
- D. Coordinate size and location of equipment access openings

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide the Bryan Boiler product indicated on Drawings, or a comparable product by one of the following:
- B. Parker Boiler
- C. Cleaver-Brooks
- D. Or Approved Equal

2.2 GENERAL

- A. The boiler shall be constructed and assembled as a completely packaged unit ready for field connections to the water supply, return connection, electrical power supply, fuel supply(s), relief valve discharge, building management controls and flue-gas vent. Boilers shall be delivered either assembled or disassembled for field erection, as indicated by field conditions.
- B. The water boiler shall be manufactured in strict accordance with ASME Heating Boiler Code, Section IV, and shall bear the ASME "H" stamp for maximum working pressure of 160 PSIG and 250° F temperature.
- C. The boiler shall also be built to withstand 150 degree temperature difference between supply and return water temperature.
- D. The boiler shall have no less than 5 sq. feet of heating surface per boiler horsepower.
- E. The boiler shall be a factory-fabricated and -assembled water-tube (flexible tube) boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue gas vent, supply and return connections, and controls. Boiler shall be provided with means for rigging.
- F. Boiler capacity and performance shall be in accordance with the schedule shown on the Contract Drawings
- G. Boilers shall fit into the space shown on the Contract Drawings, including space for maintenance in accordance with manufacturer's recommendations.

2.3 VESSEL AND TUBE CONSTRUCTION

- A. The boiler shall be constructed on a heavy steel frame. The boiler pressure vessel shall be provided with adequately sized upper and lower drums. A minimum of two downcomers shall be provided and shall be located inside furnace chamber to maximize proper thermal internal water circulation. No external water circulation source shall be required. Steel water tubes shall be 1½" O.D., 095 wall thickness, six-pass, flexible serpentine bend design, not subject to thermal shock damage. Individual water tubes shall be easily removable and replaceable without either welding or rolling. The boiler shall have no more than two tube configurations. The boiler shall be furnished with an adequate number of tappings and inspection openings to facilitate internal boiler inspection and cleaning.

2.4 FURNACE/COMBUSTION CHAMBER CONSTRUCTION

- A. Access to the furnace/combustion chamber shall be gained by a hinged access door(s) with an opening of no less than 26" wide x 62" high maximum to allow for inspection of the interior chamber and the burner head. All remaining panels shall be individually removable. All access panels shall be affixed to the pressure vessel frame, insulated with 2" mineral fiber mono block and 2" high temperature ceramic blanket insulation, and fully gasketed for pressurized firing. Combustion chamber shall have flame observation ports in front or back.

- B. The furnace/combustion chamber shall be primarily of water-wall design with one side of removable panels. The stationary interior wall shall be lined with 1" mineral fiber mono block and 1" ceramic blanket insulation. The front and rear walls shall be insulated with 4" mineral fiber mono block and 2" ceramic blanket. The floor beneath the tubes shall be lined with 2" mineral fiber mono block insulation and 2" ceramic blanket. The boiler furnace/combustion chamber and flueways shall be designed to operate at a positive at the boiler flue outlet.

2.5 JACKET CONSTRUCTION

- A. The boiler shall be complete with a metal jacket, 16 gauge, zinc-coated rust resistant steel casing, finished with a suitable heat resisting paint and shall be constructed on a structural steel frame and properly insulated with no less than 1½" fiberglass insulation. Complete jacket and insulation shall be easily removable and reinstalled. The boiler shall incorporate individually removable jacket doors, with handles providing easy access to combustion chamber and access panels. The entire tube area shall be easily accessible for fireside cleaning.
- B. All appropriate controls shall be mounted on boiler front, where possible.
- C. The boiler vessel shall be warranted for 25 years against thermal shock on a non-prorated basis.

2.6 BOILER TRIM

- A. The following trim and controls shall be furnished:
 - 1. Combination thermometer and pressure gauge with thermowell
 - 2. Water temperature control operator
 - 3. High limit safety control
 - 4. Low water cutoff
 - 5. ASME safety relief valve(s)
 - 6. Automatic control valve (open/closed) for hot water flow through boiler.

2.7 BURNER

- A. Boiler shall be furnished with a UL-approved fuel burning system, in full accordance with the requirements of state and local codes, the local gas utility, NFPA 85, and other applicable regulatory bodies.
- B. Boiler shall be provided with a forced-draft flame retention gas burner. Burner shall be complete with integral motor and blower for supplying sufficient combustion air with normal vent conditions. Burner shall be as manufactured by Powerflame, or equal.
- C. Burners shall be factory mounted on the boiler.
- D. Burners shall burn natural gas, digester gas, or both; as noted on the Contract Drawings. Burners firing digester gas shall be provided with natural gas pilots. Dual-fuel burners shall fire either natural gas or digester gas, and shall be provided with complete gas trains and controls for firing each.
- E. Burners shall be modulating type, with minimum 5-to-1 turndown ratio.

- F. Natural gas supply pressure ranges from 7 to 11”w.c. The boilers shall be capable of firing gas at any pressure within this range.
- G. Digester gas availability and properties vary over time, within ranges as follows:
1. Methane content: 50 to 65% by volume (63.61% by volume as tested)
 2. Carbon Dioxide 35 to 50% by volume (35.30% by volume as tested)
 3. Water Vapor: 3 to 6% by volume, saturated (not tested)
 4. Nitrogen: 0 to 10% by volume (0.85% by volume as tested)
 5. Oxygen: 0 to 5% by volume (0.20% by volume as tested)
 6. Hydrogen sulfide: trace to 2% (90,000 ppbV as tested)
 7. Specific Gravity: 0.85 to 0.95 (0.9 as tested)
 8. Gross Heating Value (Dry Gas @ 60F and 14.696 psia): 600 to 650 Btu/ft³ (645.7 Btu/ft³ as tested)
 9. Digester gas supply pressure ranges from 7 to 13”w.c. The boilers shall be capable of firing gas at any pressure within this range
- H. A copy of the digester gas test report is included as a Contract Insert.
- I. The following components shall be furnished for each gas train:
1. Main manual gas shutoff valves.
 2. Motorized gas valve operator and auxiliary safety shutoff gas valve.
 3. High and low gas pressure switches.
 4. Gas pilot shutoff and solenoid valves.
 5. Gas pilot ignition assembly with ignition transformer
 6. Pilot and main gas pressure regulators
- J. Unless otherwise indicated, boiler shall include burner-mounted control panel furnished with:
1. Operator switches, as follows:
 - a. On/Off control switch
 - b. Manual/Automatic firing rate control switch
 2. The following indicator lights:
 - a. “Call for Heat” indicator light
 - b. “Ignition On” indicator light
 - c. “Fuel On” indicator light
 - d. “Alarm” indicator light
 - e. “Natural Gas On” indicator light
 3. Firing Rate Potentiometer
 4. Air safety switch
 5. Electronic combustion safety control
- K. Piping and burner components handling digester gas shall be constructed from Type 316 stainless steel.

2.8 SERVO-MOTOR-BASED BURNER CONTROL SYSTEM

- A. Where indicated, provide microprocessor-based burner control system.
- B. Each burner shall be provided with a control system. System shall control fuel, combustion air, boiler sequencing, and flame supervision. System shall provide:

1. Automatic start, operation, and shutdown of each boiler
 2. Microprocessor-based control
 3. Fully metered combustion control
 4. Micro-modulation of fuel/air ratio control
 5. Two fuel curve capability
 6. Three servomotor channel control
 7. One variable-speed-drive channel control
 8. Internal flame safeguard control
 9. Full flame supervision with self-check ultra-violet, infra-red, or ionization flame detection.
 10. Lead-lag intelligent boiler sequencing
 11. PID control of water temperature
 12. Field configuration of control strategies
- C. Control panel shall include:
1. PLC with dual-core safety processor.
 2. Touchscreen interface
 3. Direct power to flame supervision
 4. Gas pressure sensor monitoring
 5. Gas valve proving system
 6. External input from combustion air proving (permissive).
 7. Burner control functions with user configurable timings
- D. External outputs:
1. Combustion air on/off
 2. Boiler circulating pump start/stop
- E. External inputs:
1. Combustion air proving switch (permissive)
 2. Boiler circulating pump proving switch
- F. Burner control system shall include servomotors, probes, scanners, sensors, valves, and other components to support the burner control system.
- G. All logic, sequencing, timing, start-stop, fault detection, and annunciator logic shall be performed by microprocessor(s).
- H. Start-up sequencing shall include combustion air blower start, furnace purge, burner light-off, and release to modulation. Shutdown sequencing shall include burner shutoff, furnace purge, and combustion air blower stop.
- I. The following operator control switches and indicator lights shall be provided:
1. On/Off control switch
 2. "Call for Heat" indicator light
 3. "Ignition On" indicator light
 4. "Fuel On" indicator light
 5. "Alarm" indicator light
 6. Manual/Automatic firing rate control switch
 7. Firing Rate Potentiometer
 8. "Natural Gas On" indicator light

- 9. "Digester Gas On" indicator light
- 10. Auto/Natural Gas selector switch
- J. Burner control system shall be Autoflame MK8 or equal. Burner control system shall be mounted and wired at the boiler manufacturer's factory.
- K. The burner control system shall include capability to interface with the local DDC system serving the boiler room. The burner control system shall share information with the DDC system, for display to the operator.
- L. The burner control system shall operate in conjunction with the DDC system to provide the sequence of operation, per Section entitled "Sequence of Operations for HVAC". Provide full coordination of controls with the DDC system, for a complete and operating system
- M. Each burner control system shall be capable of stand-alone operation, if desired by operators or if DDC system is inoperable.

2.9 ELECTRICAL

- A. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

2.10 SOURCE QUALITY CONTROL

- A. Test and inspect boilers according to the ASME Boiler and Pressure Vessel Code, Section IV. Boilers shall be test fired in the factory with a report attached permanently to the exterior cabinet of the boiler for field reference.
- B. Burner Test: Test and adjust burner at factory to eliminate excess oxygen, carbon dioxide, oxides of nitrogen, and carbon monoxide in the flue gas and to achieve combustion efficiency.
- C. Hydrostatic Test: perform hydrostatic test of boiler at factory.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.

- D. Verify that ground connections are in place and that installation of grounding described in Section “Grounding” is complete.

3.2 INSTALLATION

- A. Install as shown on the Contract Drawings and in accordance with the manufacturer’s installation instructions.
- B. Boiler Foundation: Mount boiler on a 6-inch high concrete pad according to the manufacturer’s erecting instructions.
- C. Install piping, venting, and electrical connections in a manner that allows for service and maintenance.
- D. Boiler Vent System: Install boiler vent system in accordance with manufacturer’s recommendations.
- E. Gas Train Installation: Install gas trains in accordance with listing authority. Install gas trains and gas train vents in accordance with the International Fuel Gas Code and NFPA 54.
 - 1. Provide dirt leg, manual isolation valve, and union or flange connection upstream of natural gas train
 - 2. Provide dirt leg with moisture trap, manual isolation valve, and union or flange connection upstream of digester gas train.
 - 3. Vent connections shall be piped to outdoors at full size of connection, and provided with vent protector. Provide roof or wall penetrations necessary for installing vents. Vent piping shall be same material as gas piping system.
- F. Pipe relief valve discharge to floor, with discharge as near as possible to floor drain. Piping shall be full size of relief valve outlet.
- G. Provide shutoff valve and union or flange connection at hot water supply and hot water return connections to boiler.

3.3 MANUFACTURER’S FIELD SERVICES

- A. Engage a factory-authorized service representative to perform the following inspections, checks, and supervision of testing:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with the manufacturer’s installation recommendations and requirements.
 - 2. Set field-adjustable settings to the values recommended by the equipment manufacturer.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and components.
 - 4. Supervise tests performed by independent testing firms. Witness initial energization and perform or supervise startup services.
 - 5. Prepare written report to record the following:
 - a. Inspections and checks carried out on site.
 - b. Test procedures used.
 - c. Test results that comply with requirements.

- d. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- B. Provide separate field services for digester heat system boilers and building heat system boilers.

3.4 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment.
 - 1. Train Owner's maintenance personnel for a minimum of 4 hours on procedures and schedules for energizing and de-energizing, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Demonstrate tube removal and replacement.
 - 3. Review data in Operation and Maintenance manuals.
 - 4. Schedule training with Owner, with at least 14 days advance notice.

3.5 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.6 IDENTIFICATION

- A. Identify as specified in Section "Identification for HVAC Piping and Equipment".

3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.8 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 73 00

AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes air handling units.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
1. Ohio Mechanical Code
 2. International Energy Conservation Code
 3. American Society for Testing and Materials (ASTM)
 4. American National Standards Institute (ANSI)
 5. National Fire Protection Association (NFPA)
 6. Underwriters Laboratories (UL)

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

1.4 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following shall also be submitted:
1. Provide fan curves with specified operating point clearly plotted.
 2. Sound emission data for each unit.
 3. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
 4. Submit product data on corrosion-resistant coatings.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
1. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.
 2. Submit product data of filter media, filter performance data, filter assembly, and filter frames.
- C. Shop Drawings:
1. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

- D. Manufacturer Instructions:
 - 1. Submit manufacturer's installation instructions.
 - 2. Submit control panel installation and operating instructions.
- E. Closeout Submittals
 - 1. Operation and Maintenance Data.
 - 2. Warranty Documentation.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Handle components according to manufacturer's written instructions. Use factory-installed lifting provisions.

PART 2 - PRODUCTS

2.1 AIR HANDLING UNIT

- A. Manufacturers
 - 1. Trane
 - 2. Carrier
 - 3. Or approved equal
- B. General
 - 1. Air handling unit shall be modular indoor air handler. Unit shall be factory-assembled and shall include casing, mixing box, filters, cooling coil, heating coil, fan, power, controls, and safeties.
 - 2. Unit physical size shall be as shown on the drawings. Unit shall fit into the space available in the mechanical room, with adequate space for maintenance and operation of the unit.
 - 3. Capacity and performance shall be as scheduled on the drawings.
 - 4. Corrosion-resistant coating shall resist the corrosive effects of gases and vapors found in a municipal wastewater treatment plant environment..
- C. Casing
 - 1. Unit casing and accessories shall be fabricated from heavy gauge steel suitably reinforced to provide rigidity. Casing shall be double wall, with ½" thick insulation between walls. Casings shall be airtight. Complete access shall be provided to all internal components through gasketed access doors. Access doors shall include full-length hinges.
 - 2. Casing shall be provided with corrosion-resistant coating inside and out.
- D. Mixing Box
 - 1. The mixing box shall include outside air intake damper, return air damper, and economizer relief damper and fan. Dampers shall be arranged to promote mixing of outside and return air streams.
 - 2. The outside air damper shall be tight-shutoff type, with blade and jamb seals, to minimize leakage when damper is closed.
 - 3. Outside air intake shall be provided with an air flow measurement station and bird screen, and shall be covered with a weather hood to minimize intake of precipitation.

4. Return air shall be drawn up through roof opening.
- E. Filters
1. Filters shall be 2-inch thick, throwaway type, MERV 8 pleated panel filters. Filter face velocity shall be less than 500 fpm.
 2. Filter section shall include access doors with full-length hinges.
- F. Supply Air Fan
1. Each unit shall be supplied with centrifugal forward curved, DWDI fan(s) rated in accordance with AMCA standards. The fan shall be mounted on a solid shaft. Shaft shall be designed for a maximum operating speed not to exceed 75% of its first critical speed. Bearings shall be heavy-duty industrial re-greasable type. Bearings shall be external type. Blowers shall be driven by a V-belt package sized with a capacity that is 25% greater than the motor horsepower. Multiple belt applications must be matched sets. Drives are to be adjustable for motor sizes through 7-1/2 HP, and fixed for 10 HP and larger. Motor shall be single-speed, totally enclosed, fan-cooled, inverter-duty, premium-efficiency type. Motor shall be mounted on an adjustable slide base. A belt guard shall be provided for protection
 2. Fan, motor, and drive shall be selected based on the resistance of wet coils and partially loaded filters [1/2 (clean plus dirty resistance)]. Motor shall be activated by a starter to be provided with unit. Motor and contactor are located inside unit.
 3. Fan shall discharge supply air downward through roof opening.
- G. Cooling Coils
1. Coiling coils shall be direct-expansion refrigerant type.
 2. Coils shall be constructed from aluminum plate fins and seamless copper tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.
 3. Coil casings shall be constructed of steel with formed end supports and top and bottom channels. Coil casings shall include space to enclose insulated hot water piping connecting to the coil.
 4. Coils shall be provided with corrosion-resistant coating.
 5. Cooling coil shall be selected for a maximum face velocity of 500 fpm.
- H. Heating Coils
1. Coils shall be constructed from aluminum plate fins and seamless copper tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.
 2. Coils shall have horizontal tubes and same end connections.
 3. Coil casings shall be constructed of steel with formed end supports and top and bottom channels. Coil casings shall include space to enclose insulated hot water piping connecting to the coil.
 4. Install coils such that headers and return bends are enclosed by unit casings.
 5. Coils shall be provided with corrosion-resistant coating.
 6. Performance of the coil shall be AHRI-certified. Coil shall be ETL listed to UL standard 1995.

I. Drain Pans

1. Coil sections shall be provided with sealed double-wall drain pans constructed of G90-U galvanized steel exterior panels and stainless steel interior liner. Encase insulation between exterior and interior walls. Drain pans shall be sloped in 2 planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. Units with cooling coils shall have drain pans under complete cooling coil section. Units with heating coils shall have a drain pan under complete heating coil segment to ensure proper drainage during cleaning. Drain pan connections will be to the side of the unit to enable proper trapping. Units without 2-way sloped drain pans shall coat drain pans with anti-microbial treatment.

J. Electrical

1. Unit power shall be factory-wired. Electrical components shall be factory-mounted and wired. Unit shall include a disconnect switch for single point electrical service connection.

K. Controls

1. Unit controls shall be furnished and installed by the unit supplier.
2. Controls shall be BACnet compatible, and shall interface directly with DDC system, such that the DDC system can completely monitor and control all hardware and software points.
3. Unit controls, combined with DDC system, shall provide sequence of operation described in Section entitled "Sequence of Operation".

L. Air handling unit shall include the following options and accessories

1. Corrosion-resistant coating on coils, casing interior, and casing exterior
2. Unit-mounted disconnect switch
3. Convenience GFCI outlet (NEMA 5-20R) factory wired to remain energized when power to unit is de-energized (line side of disconnect)
4. Control power transformer
5. Minimum NEMA 12 electrical enclosures.

2.2 AIR-COOLED CONDENSING UNIT

- A. Air handling unit shall be provided with matching air-cooled condensing unit. Unit shall be product of the same manufacturer as air handling unit.
- B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.
- C. Compressor: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and back-seating service access valves on suction and discharge ports.
1. Capacity control shall be provided through digital scroll compressor or variable-frequency drive.
- D. Refrigerant: R-410a.

- E. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including sub-cooling circuit and back-seating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant. Coil shall be provided with corrosion-resistant coating.
- F. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:
 - 1. Permanently lubricated, ball-bearing totally-enclosed motors.
 - 2. Separate motor for each fan.
 - 3. Dynamically and statically balanced fan assemblies.
- G. Operating and safety controls include the following:
 - 1. Manual-reset, high-pressure cutout switches.
 - 2. Automatic-reset, low-pressure cutout switches.
 - 3. Low-oil-pressure cutout switch.
 - 4. Compressor-winding thermostat cutout switch.
 - 5. Three-leg, compressor-overload protection.
 - 6. Control transformer.
 - 7. Magnetic contactors for compressor and condenser fan motors.
 - 8. Timer to prevent excessive compressor cycling.
- H. Accessories:
 - 1. Low-Ambient Controller: Controls condenser fan speed to permit operation down to minus 20°F, with time-delay relay to bypass low-pressure switch.
 - 2. Gage Panel: Package with refrigerant circuit suction and discharge gages.
 - 3. Hot-gas bypass kit.
- I. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:
 - 1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
 - 2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
 - 3. Gasketed control panel door.
 - 4. Non-fused disconnect switch, factory mounted and wired, for single external electrical power connection.
 - 5. Condenser coil hail guard.
- J. Verification of Performance: Rate compressor and condenser units according to ARI 306/110.
- K. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning".
- L. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

3.2 INSTALLATION

- A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Provide redundant freezestat installed in unit. Provide wiring suitable for terminations same as primary freezestat, for future connection by Owner when needed.
- C. Include one fan re-sheave (change belts and pulleys), if needed based on balancing, to match fan performance to duct system as installed.

3.3 SPARE EQUIPMENT

- A. Provide one (1) additional set of pleated media filters. Furnish one (1) additional complete set of fan motor drive belts.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Engage a factory-authorized service representative to perform the following inspections, checks, and supervision of testing:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with the manufacturer's installation recommendations and requirements.
 - 2. Set field-adjustable settings to the values recommended by the equipment manufacturer.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and components.
 - 4. Supervise tests performed by independent testing firms.
 - 5. Witness initial energizing of unit, and perform or supervise startup services.
 - 6. Prepare written report to record the following:
 - a. Inspections and checks carried out on site.
 - b. Test procedures used.
 - c. Test results that comply with requirements.

- d. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.5 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment.
 - 1. Train Owner's designated personnel on operation and maintenance of equipment. Complete course training shall be provided twice to accommodate work shifts. Allow a minimum of 8 hours for each complete training course. Training shall be divided into 4-hour sessions on different days, to accommodate work schedules.
 - 2. Training shall include review of unit provided, operation, troubleshooting, servicing, and maintaining equipment. Review data in Operation and Maintenance manuals.
 - 3. Schedule training with Owner, with at least 10 days advance notice.

3.6 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.7 IDENTIFICATION

- A. Identify as specified in the Section "Identification for HVAC Piping and Equipment."

3.8 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 23 73 14

INDOOR MAKE-UP AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Indoor Makeup Air Unit
 - 2. Combustion Air Make-Up Air Unit

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. American National Standards Institute (ANSI)
 - 3. National Fire Protection Association (NFPA).
 - 4. International Energy Conservation Construction Code.
 - 5. International Mechanical Code.
 - 6. Underwriters Laboratories (UL).

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
 - 1. Vertical and horizontal runs, offsets, and transitions.
 - 2. Clearances for access above and to the side.
 - 3. Show dimensions and details, including connections.
 - 4. Support locations, type of support, and weight on each support.
 - 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following shall also be submitted:
 - 1. Provide fan curves with specified operating point clearly plotted.
 - 2. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
 - 3. Submit product data on corrosion-resistant coatings.

- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
 - 1. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.
 - 2. Submit product data of filter media, filter performance data, filter assembly, and filter frames.
- C. Shop Drawings:
 - 1. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.
- D. Manufacturer Instructions:
 - 1. Submit manufacturer's installation instructions.
 - 2. Submit control panel installation and operating instructions.
- E. Closeout Submittals
 - 1. Operation and Maintenance Data.
 - 2. Warranty Documentation.

1.5 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver in shipping splits that can be moved past obstructions in the delivery path.
- B. Coordinate delivery to allow movement into designated space.
- C. Handle components according to manufacturer's written instructions. Use factory-installed lifting provisions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide air handling unit as shown and scheduled on the Contract Documents. All internal components specified in the air handling unit schedule shall be factory furnished, installed and shipped. Unit capacity shall meet or exceed that indicated in the schedules.

2.2 INDOOR MAKE-UP AIR UNIT

- A. Casing
 - 1. Unit casing and accessories shall be fabricated from heavy gauge steel suitably reinforced to provide rigidity. All panels shall be galvanized steel. All casings

shall be airtight. Complete access shall be provided to all internal components through gasketed access doors.

2. Casing shall be provided with corrosion-resistant coating.

B. Blower Section

1. Each unit shall be supplied with centrifugal forward curved, DWDI fan(s) rated in accordance with AMCA standards. The fan or fans shall be mounted on a solid shaft for single blowers and a hollow shaft for double blowers. Shaft shall be designed for a maximum operating speed not to exceed 75% of its first critical speed. Bearings are to be heavy-duty industrial re-greasable type. Bearings are to be external type. Blowers are to be driven by a V-belt package sized with a capacity that is 25% greater than the motor horsepower. Multiple belt applications must be matched sets. Drives are to be adjustable for motor sizes through 7-1/2 HP, and fixed for 10 HP and larger. Motor shall be single-speed totally enclosed fan-cooled type. Motor shall be single-speed totally enclosed fan-cooled, inverter-duty, premium efficiency type. Motor to be mounted on an adjustable slide base. Motor is to be mounted external to the cabinet. A belt guard shall be provided for protection.

C. Heating Coil

1. The heating coil shall be a horizontal tube integral face and bypass coil consisting of built-in series of finned heating elements and bypasses with interlocked dampers controlled by an electric damper motor and an airstream thermostat. Unit casing and dampers shall be fabricated of stainless steel. Coil shall be capable of maintaining a constant discharge air temperature regardless of variations in the entering air temperature. Full hot water flow shall be provided to the coil at all times.
2. Proportion of the air shall be such that the air temperature at any point in a plane parallel to the face of the coil three feet downstream from the coil's leaving side will not vary more than 5 degrees F from the average discharge temperature.
3. Finned heating elements shall be fabricated of seamless copper tubes with rectangular aluminum fins spaced not closer than 12 fins per inch. Each tube shall be brazed to the inlet and return headers. Finned elements shall be factory tested at 500 psig hydrostatic pressure.
4. Coil shall be provided with corrosion-resistant coating. Coating shall resist the corrosive effects of gases and vapors found in a municipal wastewater treatment plant environment.
5. Air pressure drop through the coil shall not vary more than plus or minus 5 percent regardless of the internal damper position.
6. Performance of the coil shall be AHRI-certified. Coil shall be ETL listed to UL standard 1995.

D. Electrical

1. Unit power shall be factory-wired. Electrical components shall be factory-mounted and wired. Unit shall include a disconnect switch for single point electrical service connection.
2. Electrical enclosures shall be minimum NEMA 12.

E. Controls

1. Unit shall include factory-mounted and factory-wired electric controls.
2. Supply fan motor shall be provided with variable-frequency drive. Drive shall be manually adjusted to achieve scheduled air flow rate.
3. Mixing box dampers shall be provided with electric actuator(s). Dampers shall open to 100% outside air position when unit is energized. Dampers shall move to 25% outside air and 75% return air position on external signal. Dampers shall return to outside air damper closed when unit is de-energized.
4. Face and bypass dampers shall be provided with electric actuator(s). Controller shall modulate dampers to maintain discharge air temperature setpoint.
5. Each unit shall be provided with a freezestat. Each unit shall also be provided with a discharge air temperature cut-out thermostat, arranged and wired to act as a back-up freezestat. Freezestat and cut-out thermostat shall be interlocked to shut off the unit fan if low temperature is detected downstream of the heating coil.

F. Sequence of Operation

1. When unit is energized, outside air damper shall open and fan shall run. Face and bypass dampers shall modulate to maintain discharge air temperature setpoint (50°F, adj.).
2. When unit is de-energized, fan shall stop and outside air damper shall close.

G. Make-up air unit shall include the following:

1. Variable frequency drive for supply fan motor
2. Discharge louver box
3. Inlet filter box
4. Electric air stream controls
5. Freezestat interlocked with unit fan
6. Back-up freeze protection (discharge air temperature cut-out thermostat)
7. Combined V-bank filter with mixing box
8. Inlet air damper with electric two-position damper motor
9. Insulated fan box
10. Vibration feet
11. Painted cabinet

H. Filter pressure drop shall be taken as halfway between clean and dirty.

I. Unit shall be LJ wing Model SAS or approved equal.

2.3 COMBUSTION AIR MAKE-UP AIR UNIT

A. General

1. Factory-assembled make-up air unit with fan and hot water heating coil. Performance shall be as shown in the schedule. Unit shall be capable of maintaining discharge air temperature regardless of fluctuations in inlet air temperature. Each unit shall consist of a heater section containing an integral face and bypass coil consisting of built-in multiple alternate finned heating elements and bypasses. Separate dampers shall control the airflow through these face and bypass sections. Each set of dampers shall be interlocked and controlled by a separate electric or pneumatic damper motor as scheduled. Finned heating

elements shall be fabricated of seamless return bend type 3/8" o.d. copper tubes with rectangular 0.010" thick aluminum fins. Each tube shall be secured to the headers by a brazed joint. The opposite end of the tubes shall be secured by channel-shaped retainers that permit expansion and contraction. Finned elements shall be factory tested with 200 psig steam and 500 psig hydrostatic pressure.

2. Unit coil shall be provided with corrosion-resistant coating. Coating shall resist the corrosive effects of gases and vapors found in a municipal waste water treatment plant environment.
3. Unit casing and internal components shall be constructed from stainless steel or provided with corrosion-resistant coating. Coating shall resist the corrosive effects of gases and vapors found in a municipal waste water treatment plant environment.
4. Fasteners and appurtenances shall be stainless steel.

B. Fan

1. Unit shall have a propeller type fan blade driven by a TEFC, inverter-duty, premium-efficiency motor with characteristics as scheduled.

C. Heating Coil

1. The heating coil shall be a horizontal tube integral face and bypass coil consisting of built-in series of finned heating elements and bypasses with interlocked dampers controlled by an electric damper motor and an airstream thermostat. Unit casing and dampers shall be provided with corrosion-resistant coating. Coil shall be capable of maintaining a constant discharge air temperature regardless of variations in the entering air temperature. Full hot water flow shall be provided to the coil at all times.
2. Proportion of the air shall be such that the air temperature at any point in a plane parallel to the face of the coil three feet downstream from the coil's leaving side will not vary more than 5 degrees F from the average discharge temperature.
3. Finned heating elements shall be fabricated of seamless copper tubes with rectangular aluminum fins spaced not closer than 12 fins per inch. Each tube shall be brazed to the inlet and return headers. Finned elements shall be factory tested at 500 psig hydrostatic pressure.
4. Coil shall be provided with corrosion-resistant coating. Coating shall resist the corrosive effects of gases and vapors found in a municipal wastewater treatment plant environment.
5. Air pressure drop through the coil shall not vary more than plus or minus 5 percent regardless of the internal damper position.
6. Performance of the coil shall be AHRI-certified. Coil shall be ETL listed to UL standard 1995.

D. Filter Box

1. Unit shall be equipped with a filter box fabricated of heavy gauge sheet steel, complete with 2" thick MERV 8 filters. Provide stainless steel construction or corrosion-resistant coating.

E. Electrical

1. Unit power shall be factory-wired. Electrical components shall be factory-mounted and wired. Unit shall include a magnetic motor starter and a disconnect switch.
2. Electrical enclosures shall be minimum NEMA 12.

F. Controls

1. Each unit shall be provided with factory mounted and wired controls. Provide a control panel mounted on unit.
2. Each unit shall be provided with a freezestat. Each unit shall also be provided with a discharge air temperature cut-out thermostat, arranged and wired to act as a back-up freezestat. Freezestat and cut-out thermostat shall be interlocked to shut off the unit fan if low temperature is detected downstream of the heating coil.
3. Each unit shall be provided with a variable-frequency drive for the fan motor. Drive shall be located in the control panel, and shall be arranged for local, manual adjustment. The drive shall be used to adjust combustion air flow to the value indicated in the schedule.
4. Unit shall be furnished with a duct-mounted thermostat to provide a constant discharge temperature regardless of inlet air temperature fluctuations.
5. Unit shall be provided with capability for remote start/stop through DDC system.
6. Unit shall output freezestat alarm to DDC system.
7. DDC connections shall be wired to terminal strip in control enclosure.

G. Sequence of Operation

1. When unit is energized, outside air damper shall open and fan shall run. Face and bypass dampers shall modulate to maintain discharge air temperature setpoint (50°F, adj.).
2. When unit is de-energized, fan shall stop and outside air damper shall close.

H. Discharge

1. Unit shall have a discharge consisting of horizontal vanes for maximum horizontal airflow projection. Discharge shall be attached to and supported by flanged brackets bolted to outlet of the unit for easy vane positioning.

I. Finish

1. Unit casing and discharge shall be painted inside and out with an air-dried alkyd enamel finish.

J. Intake Hood

1. Where noted, unit shall be furnished with an intake hood fabricated from of heavy gauge stainless steel sheet with 45 angular degree overhang and turned-up flange to prevent water from entering the unit. Intake shall be covered with stainless steel bird screen.

K. Combustion air make-up air unit shall be LJ Wing Model FAS or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Verify that proper power supply is available.

3.2 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

3.3 INSTALLATION

- A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Provide interconnecting wiring between units and remote panels, where applicable. Conduit and wiring shall be in accordance with electrical specifications.
- C. Manually adjust fan speed through variable frequency drive to obtain air flow scheduled.
- D. For units without VFD, include one fan re-sheave (change belts and pulleys), if needed based on balancing, to match fan performance to duct system as installed.
- E. Provide redundant freezestat installed in unit. Provide wiring suitable for terminations same as primary freezestat, for future connection by Owner when needed.

3.4 SPARE EQUIPMENT

- A. Provide one (1) additional set of pleated media filters. Furnish one (1) additional complete set of fan motor drive belts.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Engage a factory-authorized service representative to perform the following inspections, checks, and supervision of testing:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with the manufacturer's installation recommendations and requirements.
 - 2. Set field-adjustable settings to the values recommended by the equipment manufacturer.

3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and components.
4. Supervise tests performed by independent testing firms. Witness initial energization and perform or supervise startup services.
5. Prepare written report to record the following:
 - a. Inspections and checks carried out on site.
 - b. Test procedures used.
 - c. Test results that comply with requirements.
 - d. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.6 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment.
 1. Train Owner's maintenance personnel for a minimum of 4 hours on procedures and schedules for energizing and de-energizing, troubleshooting, servicing, and maintaining equipment and schedules.
 2. Review data in Operation and Maintenance manuals.
 3. Schedule training with Owner, with at least 10 days advance notice.

3.7 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.8 IDENTIFICATION

- A. Identify as specified in the Section "Identification for HVAC Piping and Equipment."

3.9 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.10 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 74 00

ROOFTOP UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged rooftop air conditioning units

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. Ohio Mechanical Code
 - 2. International Energy Conservation Code
 - 3. American Society for Testing and Materials (ASTM)
 - 4. American National Standards Institute (ANSI)
 - 5. National Fire Protection Association (NFPA)
 - 6. Underwriters Laboratories (UL).

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.

1.4 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following shall also be submitted:
 - 1. Provide fan curves with specified operating point clearly plotted.
 - 2. Sound emission data for each unit.
 - 3. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
 - 4. Submit product data on corrosion-resistant coatings.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
 - 1. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.
 - 2. Submit product data of filter media, filter performance data, filter assembly, and filter frames.
- C. Shop Drawings:
 - 1. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

- D. Manufacturer Instructions:
 - 1. Submit manufacturer's installation instructions.
 - 2. Submit control panel installation and operating instructions.
- E. Closeout Submittals
 - 1. Operation and Maintenance Data.
 - 2. Warranty Documentation.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Handle components according to manufacturer's written instructions. Use factory-installed lifting provisions.

PART 2 - PRODUCTS

2.1 ROOFTOP UNIT

- A. Manufacturers
 - 1. Valent
 - 2. Carrier
 - 3. Addison
 - 4. Or approved equal
- B. General
 - 1. Unit shall be an outdoor rooftop-mounted unit. Unit shall be factory-assembled and include: mixing box, filters, cooling coil, heating coil, supply air fan, relief fan, refrigerant compressor(s), condenser coil, condenser fans, refrigerant circuits and charge, power, controls, and safeties.
 - 2. Unit physical size shall be as shown on the drawings. Unit shall fit into the space available on the rooftop, with adequate space for maintenance and operation of the unit.
 - 3. Capacity and performance shall be as scheduled on the drawings.
 - 4. Corrosion-resistant coating shall resist the corrosive effects of gases and vapors found in a municipal wastewater treatment plant environment..
- C. Casing
 - 1. Unit casing and accessories shall be fabricated from heavy gauge steel suitably reinforced to provide rigidity. Casing shall be double wall, with ½" thick insulation between walls. Casings shall be airtight. Complete access shall be provided to all internal components through gasketed access doors. Access doors shall include full-length hinges.
 - 2. Casing shall be provided with corrosion-resistant coating inside and out.
- D. Mixing Box
 - 1. The mixing box shall include outside air intake damper, return air damper, and economizer relief damper and fan. Dampers shall be arranged to promote mixing of outside and return air streams.
 - 2. The outside air damper shall be tight-shutoff type, with blade and jamb seals, to minimize leakage when damper is closed.

3. Outside air intake shall be provided with a stainless steel air flow measurement station and stainless steel bird screen, and shall be covered with a stainless steel weather hood to minimize intake of precipitation.
 4. Return air shall be drawn up through roof opening.
- E. Filters
1. Filters shall be 2-inch thick, throwaway type, MERV 8 pleated panel filters. Filter face velocity shall be less than 500 fpm.
 2. Filter section shall include access doors with full-length hinges.
- F. Supply Air Fan
1. Each unit shall be supplied with centrifugal forward curved, DWDI fan(s) rated in accordance with AMCA standards. The fan shall be mounted on a solid shaft. Shaft shall be designed for a maximum operating speed not to exceed 75% of its first critical speed. Bearings shall be heavy-duty industrial re-greasable type. Bearings shall be external type. Blowers shall be driven by a V-belt package sized with a capacity that is 25% greater than the motor horsepower. Multiple belt applications must be matched sets. Drives are to be adjustable for motor sizes through 7-1/2 HP, and fixed for 10 HP and larger. Motor shall be single-speed totally enclosed fan-cooled type. Motor shall be single-speed, totally enclosed, fan-cooled, premium-efficiency type. Motor shall be mounted on an adjustable slide base. A belt guard shall be provided for protection
 2. Fan, motor, and drive shall be selected based on the resistance of wet coils and partially loaded filters [1/2 (clean plus dirty resistance)]. Motor shall be activated by a starter to be provided with unit. Motor and contactor are located inside unit.
 3. Fan shall discharge supply air downward through roof opening.
- G. Cooling Coils
1. Coiling coils shall be direct-expansion refrigerant type.
 2. Coils shall be constructed from aluminum plate fins and seamless copper tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.
 3. Coil casings shall be constructed of steel with formed end supports and top and bottom channels. Coil casings shall include space to enclose insulated hot water piping connecting to the coil.
 4. Coils shall be provided with corrosion-resistant coating.
 5. Cooling coil shall be selected for a maximum face velocity of 500 fpm.
- H. Heating Coils
1. Coils shall be constructed from aluminum plate fins and seamless copper tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.
 2. Coils shall have horizontal tubes and same end connections.
 3. Coil casings shall be constructed of steel with formed end supports and top and bottom channels. Coil casings shall include space to enclose insulated hot water piping connecting to the coil.
 4. Install coils such that headers and return bends are enclosed by unit casings.
 5. Coils shall be provided with corrosion-resistant coating.

6. Performance of the coil shall be AHRI-certified. Coil shall be ETL listed to UL standard 1995.
- I. Drain Pans
 1. Coil sections shall be provided with sealed double-wall drain pans constructed of G90-U galvanized steel exterior panels and stainless steel interior liner. Encase insulation between exterior and interior walls. Drain pans shall be sloped in 2 planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. Units with cooling coils shall have drain pans under complete cooling coil section. Units with heating coils shall have a drain pan under complete heating coil segment to ensure proper drainage during cleaning. Drain pan connections will be to the side of the unit to enable proper trapping. Units without 2-way sloped drain pans shall coat drain pans with anti-microbial treatment.
 - J. Refrigeration
 1. Compressors shall be digital-scroll or variable-speed type. Compressors shall include internal high-pressure relief, over-temperature and over-current protection, high and low refrigerant pressure protection, evaporator freeze protection, and vibration isolation. Refrigerant shall be R-410A.
 2. Refrigerant components shall include, filter drier and service gage connections. Evaporator shall have aluminum plate fins bonded to seamless copper tube.
 3. Unit shall exceed ASHRAE 90.1 energy efficiency standards.
 - K. Electrical
 1. Unit power shall be factory-wired. Electrical components shall be factory-mounted and wired. Unit shall include a disconnect switch for single point electrical service connection.
 - L. Controls
 1. Unit controls shall be furnished and installed by the unit supplier.
 2. Controls shall be BACnet compatible, and shall interface directly with DDC system, such that the DDC system can completely monitor and control all hardware and software points.
 3. Unit controls, combined with DDC system, shall provide sequence of operation described in Section entitled "Sequence of Operation".
 4. Provide two heating coil freezestats, arrange so that one is back-up to the other.
 - M. Rooftop unit shall include the following options and accessories:
 1. Corrosion-resistant coating on coils, casing interior, and casing exterior
 2. Roof curb
 3. Through-the-curb service connections
 4. Unit-mounted disconnect switch
 5. Convenience GFCI outlet (NEMA 5-20R) factory wired to remain energized when power to unit is de-energized (line side of disconnect)
 6. Control power transformer

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

3.2 INSTALLATION

- A. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Provide redundant freezestat installed in unit. Provide wiring suitable for terminations same as primary freezestat, for future connection by Owner when needed.
- C. Include one fan re-sheave (change belts and pulleys), if needed based on balancing, to match fan performance to duct system as installed.

3.3 SPARE EQUIPMENT

- A. Provide one (1) additional set of pleated media filters. Furnish one (1) additional complete set of fan motor drive belts.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Engage a factory-authorized service representative to perform the following inspections, checks, and supervision of testing:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with the manufacturer's installation recommendations and requirements.
 - 2. Set field-adjustable settings to the values recommended by the equipment manufacturer.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and components.
 - 4. Supervise tests performed by independent testing firms.
 - 5. Witness initial energizing of unit, and perform or supervise startup services.
 - 6. Prepare written report to record the following:
 - a. Inspections and checks carried out on site.
 - b. Test procedures used.
 - c. Test results that comply with requirements.

- d. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.5 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment.
 1. Train Owner's designated personnel on operation and maintenance of equipment. Complete course training shall be provided twice to accommodate work shifts. Allow a minimum of 8 hours for each complete training course. Training shall be divided into 4-hour sessions on different days, to accommodate work schedules.
 2. Training shall include review of unit provided, operation, troubleshooting, servicing, and maintaining equipment. Review data in Operation and Maintenance manuals.
 3. Schedule training with Owner, with at least 10 days advance notice.

3.6 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.7 IDENTIFICATION

- A. Identify as specified in the Section "Identification for HVAC Piping and Equipment."

3.8 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 23 74 24

OUTDOOR MAKE-UP AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Outdoor Make-Up Air Units as shown on the Contract Drawings

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
1. American Society for Testing and Materials (ASTM)
 2. American National Standards Institute (ANSI)
 3. National Fire Protection Association (NFPA).
 4. International Energy Conservation Construction Code.
 5. International Mechanical Code.
 6. Underwriters Laboratories (UL).

1.3 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation with electrical equipment, light fixtures, HVAC equipment and ductwork, piping, and roof drains.
- B. Submit specially prepared Coordination Drawings for this Project, including floor plans and sections, drawn to scale. Include scaled equipment layouts and relationships between equipment and adjacent structural, mechanical, HVAC, and electrical elements. Show the following:
1. Vertical and horizontal runs, offsets, and transitions.
 2. Clearances for access above and to the side.
 3. Show dimensions and details, including connections.
 4. Support locations, type of support, and weight on each support.
 5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

1.4 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions, the following shall also be submitted:
1. Provide fan curves with specified operating point clearly plotted.
 2. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.

1. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.
 2. Submit product data of filter media, filter performance data, filter assembly, and filter frames.
- C. Shop Drawings:
1. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.
- D. Manufacturer Instructions:
1. Submit manufacturer's installation instructions.
 2. Submit control panel installation and operating instructions.
- E. Closeout Submittals
1. Operation and Maintenance Data.
 2. Warranty Documentation.
- 1.5 QUALITY ASSURANCE
- A. Qualifications
1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.
- 1.6 DELIVERY, STORAGE AND HANDLING
- A. Deliver in shipping splits that can be moved past obstructions in the delivery path.
- B. Coordinate delivery to allow movement into designated space.
- C. Handle components according to manufacturer's written instructions. Use factory-installed lifting provisions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide make-up air unit as shown and scheduled on the Contract Documents. All internal components specified in the make-up air unit schedule shall be factory furnished, installed and shipped. Unit capacity shall meet or exceed that indicated in the schedules.
- B. Make-up air unit and controls shall be explosion-proof; unit construction shall be suitable for a Class I, Division 2, Group D classified area, in accordance with NFPA 70 (National Electrical Code).
- C. Make-up air unit shall include corrosion resistant construction suitable for vapors and gases encountered in a municipal wastewater treatment plant environment. Construction shall include stainless steel fasteners, hinges latches, dampers, screens, and other

components. Construction shall also include corrosion-resistant coatings for coils, casing, and other components.

2.2 UNIT CASING

- A. The entire unit shall be provided with a full-length, continuous, base rail channel. Base rail channels will be formed of a minimum of 12 gauge galvanized steel. All major components shall be supported from the base. Integral lifting lugs shall be provided to facilitate rigging and installation. Lifting lugs shall be suitable for use as unit tie down points.
- B. The unit shall have a frame construction consisting of integral galvanized steel vertical and horizontal structural members. The frame shall be constructed to permit complete removal of the wall and roof panels without affecting the structural integrity of the unit.

2.3 PANEL CONSTRUCTION

- A. All panels shall be completely gasketed prior to shipment with a minimum of 1/4-inch thick and 3/4-inch wide closed cell neoprene.
- B. All panels shall be insulated with at minimum 2-inch thick, 2 lb. insulation. The panel insulation must be a full 2 inches (non-compressed) throughout the entire unit. The insulation shall meet the flame and smoke generation requirements of NFPA-90A.
- C. All wall and roof panels shall be completely removable for unit access and removal of components. All panels shall be removable without affecting the structural unit frame.
- D. All panels and floors shall be double wall and shall be constructed of G90 mil galvanized sheet steel, formed and reinforced to provide a rigid assembly. The exterior casing shall be constructed of a minimum of 18 gauge galvanized steel. The interior lining shall be a solid or perforated lining of a minimum of 20 gauge galvanized steel.

2.4 ACCESS DOORS

- A. Double wall access doors shall be provided in the fan, filter and inlet segments of the unit on the drive side of the unit. Access doors must also be provided on both sides of the unit in all segments constructed with welded panels.
- B. Doors shall be double-wall construction with a solid liner and a minimum thickness of 2 inches. Doors shall be attached to the unit with a continuous, full-length piano-type stainless steel hinge. Latches shall be positive, action, creating an air-tight seal between the door and unit.

2.5 CASING FINISH

- A. The exterior of the unit shall be completely cleaned prior to application of finished coats. A prime coat of epoxy chromate shall be applied to a minimum thickness of 1.5 mils. Unit casing shall be provided with an interior and exterior coating that is corrosion resistant.
- B. Air tunnel, fans, and dampers shall all include the corrosion protection.

2.6 CENTRIFUGAL FANS

- A. The fan segment shall be equipped with centrifugal type wheels.
- B. The fan discharge shall be connected to the fan cabinet using a flexible connection to insure vibration free operation.
- C. Fan and motor shall be internally mounted and include vibration isolation.

2.7 BEARINGS AND DRIVES

- A. Fan drives shall be selected for a 1.5 service factor and anti-static belts shall be furnished.

2.8 FAN SHAFTS

- A. Fan shaft shall be selected to operate well below the first critical speed and each shaft shall be factory coated after assembly with an anti-corrosion coating.

2.9 COILS

- A. Heating coils shall be furnished to meet the performance requirements set forth in the schedule. All coils shall have performance certified in accordance with ARI Standard 410.
- B. All unit coils shall be removable from the unit by unbolting the wall panels in the coil segment. Units requiring welds to be broken, or ceiling panels to be removed, in order to replace the coil are not acceptable.
- C. Corrosion-Resistant Coating: Coils shall be provided with a corrosion-resistant coating suitable for resistance to wastewater treatment plant gas and vapors, including hydrogen sulfide.

2.10 FILTERS

- A. All filter segments shall be side service with a standard access door on the drive side of the unit.
- B. Pleated panel pre filter, 2-inch thick with a MERV rating of 8, upstream of the cooling coil.

2.11 CONTROLLER

- A. Unit controller shall be provided by the unit manufacturer. Controller shall be mounted in a panel to be mounted remote from the unit. Controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested. Controls shall be BACnet compatible.
- B. Controller shall modulate heating control valve to maintain supply air temperature setpoint

- C. Controller shall be capable of standalone operation with unit configuration, set point adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
- D. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
- E. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.
- F. Heating shall be controlled to maintain supply air temperature at 50°F (adjustable). Unit shall include supply air temperature sensor and control.
- G. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable.
- H. Remote controller in space shall be capable adjusting temperature set points, night set back, heat and cool, and fan operating mode.

2.12 REMOTE PANEL

- A. Manufacturer shall provide a unit control panel suitable for mounting remote from the unit, indoors. Panel shall be minimum NEMA 12 rated.
- B. Panel shall include controller, variable-frequency drive, power connection, disconnect switch, and all other appropriate accessories.

2.13 FACTORY START-UP

- A. A factory employed technician shall be present for unit start-up and specific calibration of control components.

2.14 POWER CONNECTION

- A. Unit shall be equipped with a single point electrical connection consisting of a disconnect branch fusing as required by standards referenced below, variable-frequency drive, control panels, lights, transformers, and wiring to all motors. The panels and all associated components shall be U.L. listed. All wiring shall comply with N.E.C. The panel shall contain a single point power connection, single-speed fan motor contactor(s) with overload device(s), three-phase ambient compensated overload heater elements, two primary control fuses, one secondary control line size fuse, terminal strip and on/off auto switch. In addition, the motor control panel shall contain a transformer for lights, receptacles and control devices.

2.15 UNIT MOUNTED DISCONNECT

- A. Each unit shall be equipped with a unit mounted nonfused disconnect. The disconnect shall be in a separate minimum NEMA 12 enclosure.

2.16 ACCESSORIES

- A. Outside air temperature sensor shall be furnished with the unit for field installation.
- B. Supply air temperature sensor shall be factory provided, installed with unit.
- C. Space thermostat with LCD screen, temperature setpoint reset and unoccupied override shall be furnished with the unit for field installation. Provide with the following:
 - 1. LCD screen.
 - 2. User functions to allow user to set on /off, operation modes cool, heat, fan, set temperature in degrees Fahrenheit, fan speed setting, day/time display, timer operation – weekly timer, room temperature, temperature range limit, clean filter display.
 - 3. Dimensions are approximately 4"x5"x3/4"
- D. Unit shall be provided with a factory installed return air smoke detector.
- E. Unit shall include a factory installed 24V control circuit transformer.
- F. Hot water heating coil shall be provided with primary and back-up (redundant) freeze stats.
- G. Birdscreen covering outdoor air inlet shall be stainless steel.

2.17 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 - 1. Trane
 - 2. Carrier
 - 3. Or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Verify that proper power supply is available.

3.2 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in systems to verify the following:
 - 1. Systems are within the limitations established by the manufacturer.
 - 2. Each utility pipe and conduit is in the correct location.

- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Install as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- C. Provide redundant freezestat installed in unit. Provide wiring suitable for terminations same as primary freezestat, for future connection by Owner when needed.
- D. Include one fan re-sheave (change belts and pulleys), if needed based on balancing, to match fan performance to duct system as installed.

3.4 SPARE EQUIPMENT

- A. Provide one (1) additional set of pleated media filters. Furnish one (1) additional complete set of fan motor drive belts.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Engage a factory-authorized service representative to perform the following inspections, checks, and supervision of testing:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with the manufacturer's installation recommendations and requirements.
 - 2. Set field-adjustable settings to the values recommended by the equipment manufacturer.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and components.
 - 4. Supervise tests performed by independent testing firms. Witness initial energization and perform or supervise startup services.
 - 5. Prepare written report to record the following:
 - a. Inspections and checks carried out on site.
 - b. Test procedures used.
 - c. Test results that comply with requirements.
 - d. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.6 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment.
 - 1. Train Owner's maintenance personnel for a minimum of 4 hours on procedures and schedules for energizing and de-energizing, troubleshooting, servicing, and maintaining equipment and schedules.

2. Review data in Operation and Maintenance manuals.
3. Schedule training with Owner, with at least 10 days advance notice.

3.7 PAINTING

- A. Perform field painting in accordance with the Section "Painting".

3.8 IDENTIFICATION

- A. Identify as specified in the Section "Identification for HVAC Piping and Equipment."

3.9 CLEANING

- A. On completion of installation, inspect interior and exterior of equipment. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.10 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 81 26

DUCTLESS SPLIT AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Ductless Split Air Conditioning Units as shown on the Contract Drawings.

1.2 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society of Mechanical Engineers (ASME)
 - 2. American National Standards Institute (ANSI)
 - 3. National Fire Protection Association (NFPA)
 - 4. International Energy Conservation Code
 - 5. Ohio Mechanical Code
 - 6. American Society for Testing and Materials (ASTM)
 - 7. Underwriters Laboratories (UL)

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. In addition to those submittals identified in the General Conditions, the following shall also be submitted:
 - 1. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- C. Indicate locations of drain and electrical rough-in connections on product data.
- D. Submit operation and maintenance data under provisions of General Conditions.
- E. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data.
- F. Warranty Documentation:
 - a. Compressor

b. Parts

G. Contract Closeout Submittals

1. Provide copy of each test report to Owner.

1.4 QUALITY ASSURANCE

A. Qualifications

- B. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

- C. Source Limitations: Obtain condensing unit and ductless split air conditioning unit and accessories through one source from a single manufacturer.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Handle ductless split heat pump system components according to manufacturer's written instructions. Use factory-installed lifting provisions.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT AIR CONDITIONING UNITS AND CONDENSING UNITS

- A. Manufacturers: Carrier 40MK, or approved equal.

- B. Description: Condensing unit: The outdoor unit shall include the inverter powered compressor, coils and power connection point for the entire system. The indoor unit fan and controls shall be powered from the outdoor unit through the connection kit. The power connection point shall include a service disconnect. The connection kit shall include refrigeration lines, power from the outdoor unit to the indoor unit and control wires. Controls shall include compressor and fan starters, overpressure safeties, wind baffles and indoor temperature adjustments to operate the system in a cooling mode with ambient temperatures down to -20°F.

- C. Description Evaporator Unit: Evaporator shall be housed in a ceiling suspended type enclosure. Evaporator shall provide the performance as scheduled and have the base characteristics of the equipment scheduled. Unit frames shall be constructed of 14 gauge welded galvanized steel with 14 and 16 gauge galvanized steel panels and access doors. The unit surface shall be phosphatized and finished with an air-dry paint to withstand 672 hours of continuous salt spray solution in accordance with ASTM B117. Provide decorative louvered panels for condenser coil protection.

- D. Refrigerant type shall be R-410A.

- E. Compressors shall be inverter driven scroll type with thermal overload protection and carry a 5 year non-prorated warranty minimum.

- F. Compressor shall include a crankcase heater.
- G. Compressor shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.
- H. Compressor shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
- I. Refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided. Finished field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line and insulated suction line.
- J. Unit shall include a factory holding charge of R-410A refrigerant and oil.
- K. Controls shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.
- L. Electrical Disconnect Switch: Provide disconnect switch.
- M. Low Ambient Control: Provide low ambient operation down to -20 deg F.
- N. Provide wired remote controller (thermostat) with the following capability
 - a. LCD screen.
 - b. User functions to allow user to set on /off, operation modes cool,, fan, set temperature in degrees Fahrenheit, fan speed setting, day/time display, timer operation – weekly timer, room temperature, temperature range limit, clean filter display.
- O. Refrigerant Line Kits: Provide soft annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed. Insulate refrigerant lines in accordance with HVAC insulation. Provide line sizes, fittings, and appurtenances in accordance with manufacturer's recommendations.
- P. Low-ambient operation: each unit shall be capable of cooling in low ambient conditions, to -20°F outdoor air temperature. Outdoor unit shall be provided with crankcase heater and wind baffle.
- Q. Indoor unit shall include capability to draw in outside air through a dedicated connection to the unit.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.

- B. Examine roughing-in of Ductless Split Air Conditioning Units to verify the following:
- C. Ductless Split Air Conditioning Units are within the limitations established by the manufacturer.
- D. Each utility pipe and conduit is in the correct location.
- E. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- F. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

3.2 INSTALLATION

- A. Install Ductless Split Air Conditioning Units as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.
- B. Coordinate installation of units with architectural and electrical work.
- C. Supply units fully charged with refrigerant and filled with oil.
- D. Refrigerant lines shall be insulated in accordance with Section entitled "HVAC Insulation".
- E. Condensate drain shall be plumbed to floor drain. Condensate piping shall be schedule 40 PVC pipe and fittings. Provide trap at unit. Insulate interior piping with ½" thick elastomeric foam insulation, see Plumbing Insulation Specification for details. Pitch pipe 1/8" per linear foot towards drain outlet

3.3 FIELD QUALITY CONTROL

- A. Leak Test: After installation, charge piping system and test for leaks. Repair leaks and retest until no leaks exist.
- B. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation. Remove malfunctioning units, replace with new components, and retest.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 23 82 00

UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Unit Heaters as shown on the Contract Drawings.
- B. Equipment includes:
 - 1. Electric Unit Heaters (EUH)
 - 2. Hot water Unit Heaters (UH)
- C. Certain features of Unit Heaters shall be as scheduled on the Contract Drawings.

1.2 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society of Mechanical Engineers (ASME)
 - 4. National Fire Protection Association (NFPA)
 - 5. International Fire Code
 - 6. Ohio Building Code
 - 7. International Energy Conservation Code
 - 8. Underwriters Laboratories (UL)
 - 9. National Electrical Code (NEC).

1.3 SUBMITTALS

- A. Submit the following in accordance with the General Conditions.
- B. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data
 - 1. Include materials of construction.
 - 2. Include product data demonstrating unit capacity.
 - 3. Include product data on each corrosion resistant coating which demonstrates that coating is suitable for application.

1.4 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.

PART 2 - PRODUCTS

2.1 ELECTRIC UNIT HEATERS (EUH)

A. Standard Electric Unit Heaters

1. Electric unit heaters shall consist of heating element, fan, motor, controls, and cabinet.
2. Heating element shall be metal sheath type with built-in overheat protection.
3. Fan shall be direct-drive axial-flow type. Fan shall be factory balanced.
4. Controls shall be factory mounted and wired, and shall include magnetic contactors, control power transformer.
5. Unit manufacturer shall provide pre-wired integral thermostat as scheduled.
6. Cabinet shall be heavy-gauge steel with adjustable discharge louvers and rear protective grille.
7. The heater shall be provided with the appropriate wall- or ceiling-mounting kit designed to bear the weight of the heater assembly.
8. Provide the following:
 - a. 24-volt relay, with transformer
 - b. 120-Volt control circuit
 - c. Fusing (under 48 amps)
 - d. Diffuser cones for vertically mounted heaters
 - e. Built-in disconnect switch (100 amps maximum).
9. Indeeco UHIR Series (horizontal) or UVI Series (vertical), or equal.

B. Corrosion Resistant Electric Unit Heaters

1. Electric unit heaters shall consist of heating element, fan, motor, controls, and cabinet. Unit shall be UL listed.
2. Heating Elements: Unit shall have industrial grade, Type 316 stainless steel tubular elements with stainless steel fins.
3. Fan Motor Assembly: Motor shall be totally-enclosed, fan-cooled type, with epoxy-coating and permanently lubricated ball bearings. Motor shall be factory wired to NEMA 4X enclosure. Motor shall be fitted with a powder-coated aluminum fan.
4. Housing: Heating elements and motor shall be enclosed in a round, 16-gauge stainless steel shroud.
5. Inlet and Outlet Grilles: Unit shall have adjustable, stainless steel louvered outlet grille which can be rotated 90-degrees to direct airflow up, down, left, or right. Unit shall include heavy-gauge stainless steel rear grille.
6. Control Enclosure: Non-metallic, NEMA 4X enclosure shall house element terminals and built-in controls.
7. Built-In Controls: Built-in controls shall include automatic reset over-temperature cutout, fan delay relay, controlling contactor, transformer for 24-Volt control circuit, terminal block for field wiring, and a separate motor contactor (when required). Unit shall include factory mounted and wired disconnect switch. Where noted, unit heater shall be provided with NEMA 4X remote thermostat.
8. Mounting Bracket: Unit heater shall be provided with stainless steel swivel mounting bracket, which can be used for either wall or ceiling mounting.
9. Indeeco TRIAD or approved equal.

C. Explosion Proof Electric Unit Heaters

1. Electric explosion-proof unit heaters shall have the capacity rating, voltage and phase specified in the schedule. They shall be forced fan type, Factory Mutual and CSA approved for:
 - a. Class I, Divisions 1 and 2, Group D; Ignition Temperature Code No. T3C, 320 deg F (Standard construction).
2. Unit heaters shall have dual automatic reset thermal cutouts for redundant over-temperature protection, controlling magnetic contractor and 24-volt control circuit transformer housed in a NEMA 7, cast aluminum enclosure.
3. The heat exchanger shall be industrial grade, type 304 stainless steel finned tubular heating elements.
4. Housing shall be round, 16-gauge stainless steel shroud. Housing shall include an adjustable stainless steel louvered outlet grille capable of directing discharge air 45-degrees up or down. Housing shall also include a heavy-gauge stainless steel rear grille to protect the fan blade.
5. Heat exchanger and aluminum fan blade shall be enclosed in an industrial grade, corrosion resistant cabinet fabricated from powder coated, 14 gauge steel. Adjustable outlet louvers to have minimum opening safety stops.
6. Fan motor shall include permanently lubricated ball bearings and built-in thermal overload protection. Motor shall operate at 120-volt, 1-phase power, and be prewired to the control enclosure to eliminate the need for separate field wiring to the motor. Motor shall be UL listed for Class I, Group D applications.
7. The heater shall be provided with the appropriate stainless steel wall-mounting kit designed to bear the weight of the heater assembly.
8. Provide the following options:
 - a. Factory-installed and pre-wired thermostat to control the unit heater. Adjustable from 50°F to 90°F.
 - b. Dirty-duty corrosion-resistant construction providing corrosion-resistant coating to all aluminum parts.
9. Indeeco Compact or approved equal by Chromalox or Trane.

2.2 HOT WATER UNIT HEATERS

A. Horizontal Discharge

1. Unit heaters shall be complete with hot water coil, fan, motor, fan guard, louvered diffuser, hangers and casing. All unit components shall be provided with corrosion resistant features. Units shall be industrial quality designed for use in humid areas. Casings shall consist of front and back halves. Both halves shall be joined together at the top and bottom utilizing the coil mount screws. Casing top shall be provided with threaded hanger connections for unit suspension. Fan venturi is formed in casing back half.
2. Coils shall be of the extended surface type, utilizing aluminum fins and DLP-type copper tubes with malleable iron supply and return connections. Coils shall be of serpentine design; all tube bends shall be brazed and shall have individual expansion bends. Tubes shall be mechanically bonded to the collars of the fins. The coils shall be warranted for operation at hot water pressures and temperatures up to 150 psig and 375°F. Fins shall be continuous across the width

and depth of the condenser and are vertically oriented to minimize the collection of dirt and dust. All coils shall be leak tested at 165 to 200 psig, air under water.

- B. Vertical Discharge
 - 1. Casings shall consist of two circular 18 gauge steel covers. Bottom cover shall have a die-formed fan venture. Top cover shall incorporate a motor cooling cone.
 - 2. Coils shall be circular to account for natural expansion. Each tube shall be continuous between supply and return header. All tube joints shall be silver soldered. Copper tubes shall be 5/8" OD with 0.028" wall thickness.
- C. Provide corrosion-resistant coating on coil. Coating shall be suitable for gases and vapors commonly found in a municipal wastewater treatment plant environment.
- D. Where installed in classified areas, or where noted, provide explosion-proof unit heaters suitable for installation in Class I, Division 1 or 2, Group D environments.
- E. Fans shall be aluminum and shall be secured to a steel hub. Each fan shall be balanced and shall be equipped with a combination fan guard/ motor-mounting bracket. Guard shall be constructed of steel rod.
- F. All casing shall be treated to prevent corrosion and painted with a corrosion resistant, baked, polyester powder coat finish.
- G. Motor: Motors shall be designed for continuous duty and shall operate in a maximum ambient temperature of 104°F. Motor shall be totally enclosed and shall include built-in thermal overload protection. Motor wiring shall be terminated in an electrical junction box either supplied on the unit heater casing or as an integral part of the motor.
- H. Manufacturers: Trane or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- C. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.

3.2 INSTALLATION

- A. Equipment shall be installed, supported, cleaned, tested, and adjusted in accordance with manufacturer's recommendations and instructions.
- B. Install equipment as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions.

3.3 IDENTIFICATION

- A. Identify equipment as specified in Section "Identification for HVAC Piping and Equipment."
- B. Emergency Operating Instructions: Frame and mount under clear acrylic plastic for wall mounting.
- C. Operating Instructions: Frame printed operating instructions. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchgear.

3.4 PROTECTION

- A. Protect installed equipment from damage through Substantial Completion.

END OF SECTION

SECTION 26 00 00

ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide complete, tested and fully functional electrical systems as shown on the Drawings and as specified herein.
- B. Electrical equipment and installed systems shall be suitable for the application, shall safe for the intended use, shall be fully rated for the available fault current, and shall conform to local building codes and statutory requirements.

1.2 RELATED DOCUMENTS

- A. The Drawings and General Conditions of the Contract apply to this Section.
- B. Electrical requirements specified in this Section apply to electrical equipment and materials described in other Sections of Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities".

1.3 SCOPE OF WORK

- A. The work includes, but is not limited to, the work described in other Sections of Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities" and the following:
 - 1. Underground duct banks, manholes, and handholes
 - 2. Removal and/or relocation of existing equipment
 - 3. Temporary lighting and power as required for construction and as hereinafter specified
 - 4. Field wiring for equipment provided under other Sections of the Specification
 - 5. Thorough cleaning of all equipment prior to energization
 - 6. Acceptance testing of all equipment installed under this Division
 - 7. Protection of all equipment under this Division until the final acceptance of the job
- B. Coordinate Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities" requirements with work described in other Divisions of the Specification.
- C. Submit pre-construction submittals, shop drawings, product data, samples, design data, test reports, certificates, manufacturer's instructions, manufacturer's field reports, operation and maintenance data, closeout submittals and other specified documents to the Engineer for review and approval as described in the General Conditions, Special Provisions, this Section, and in other Sections of Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities".
- D. Perform electrical acceptance tests described in Part 3 of other Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities" Sections.
- E. The following principal items of work will be performed under other Sections unless otherwise noted:

1. Finish painting of exposed raceways, boxes, fittings, hangers, and supports as described in Division "Finishes".
2. Motors for mechanical equipment will be furnished under other Divisions of this Specification.

1.4 PROJECT CONDITIONS

- A. Ambient temperature, humidity, and elevation ranges:
 1. Ambient Temperature: 0 to 40 deg C.
 2. Humidity: Less than 90 percent (non-condensing).
 3. Altitude: Not exceeding 3300 feet (1000 m).
- B. Transformer output ratings shall be as specified in Division 26 Section "Low-Voltage Distribution Transformers".
- C. Unusual service conditions:
 1. Exposure to vapors and gasses that may result in explosive conditions.
- D. Product Selection for Restricted Space: Drawings show allowable space to scale for anticipated equipment sizes. Comply with NEC requirements for working clearances and with manufacturer's recommendations for access for maintenance. Notify the Engineer if insufficient space is available for available products.

1.5 DEFINITIONS

- A. In addition to the Definitions in the General Conditions, the following definitions apply to Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities".
 1. Acceptance Tests: power distribution and control equipment testing performed in conformance with NETA Acceptance Testing Specification
 2. AHJ: The statutory Authority Having Jurisdiction as defined in NEC Article 100 for enforcement of legally required compliance to local codes, standards, and ordinances.
 3. ANSI: American National Standards Institute
 4. AEIC: Association of Edison Illuminating Companies
 5. ASQ: American Society for Quality
 6. AWG: American Wire Gauge
 7. CFR: Code of Federal Regulations
 8. Cable: an assembly of insulated conductors
 9. Control panel: an electrical enclosure housing control logic devices and an operator control interface
 10. Commissioning: the process of testing system performance after the sequential steps of installation, testing, energization, startup (including initial adjustment and de-bugging) and functional testing of individual pieces of equipment have all been completed
 11. Contract: as used in the Electrical Specification, includes all Contract documents including Specifications and Appendices, Drawings, Addenda, and Change Orders

12. ICEA: Insulated Cable Engineers Association
13. Equipment: a general term including materials, fittings, devices, appliances, fixtures, apparatus, and the like, used as part of, or in connection with, an electrical installation (OSHA Section 29 CFR 1910.399(46) definition)
14. FM: Factory Mutual, Inc.
15. Field wiring: on-site installation of raceways & conductors to connect equipment in accordance with approved drawings
16. Field test: electrical test carried out on-site
17. Fail-safe: selection of control devices and contacts in a manner which results in safe shutdown of the equipment whenever one of the following events occurs:
 - a. Power supply failure
 - b. Loss of remote control RUN command (normal configuration: contacts close to run equipment)
 - c. Intentional and unintentional disconnection of device (normal configuration: contacts open to shut down equipment)
 - d. High contact resistance or high resistance connection
 - e. Loss of 4-20mA DC signal
 - f. Definite-time sequence takes too long, e.g., reduced voltage motor starter fails to make transition from START mode to RUN mode after a reasonable time
 - g. Defined sequence does not occur, e.g., there is no flow from a motor driven pump within a reasonable time after the motor starter contactor is energized.
18. Furnish and install: same as "Provide" below.
19. Functional testing: verification of the satisfactory performance of control logic, with due attention to the functionality of equipment protective devices, for example, overload relays, temperature switches, pressure switches, flow switches, and similar devices, under actual operating conditions
20. HV: high voltage, operating voltage over 600V (NEC definition)
21. IEEE: Institute of Electrical and Electronics Engineers, Inc.
22. ISO: International Standards Organization
23. Lineup: with respect to switchgear, switchboards, and motor control centers, a contiguous group of vertical sections with common main busbars, and including bus tie breaker sections and control sections
24. LV: low voltage, operating voltage under 600V (NEC definition)
25. Megger: insulation tester with megohm scale
26. NEC: NFPA 70, the National Electrical Code
27. NETA: International Electrical Testing Association, Inc.
28. NICET: National Institute for Certification in Engineering Technologies
29. NFPA: National Fire Protection Association

- 30. NRTL: Nationally recognized testing laboratory as defined in 29 CFR 1910.7 as it applies to testing and inspecting for safety in the workplace (OSHA definition)
- 31. Nonconformity: The nonfulfillment of a specified requirement (ASQ definition)
- 32. "Or approved equal": proposed "equal" product shall be in conformance with all specified requirements, shall be equivalent in materials of construction to specified manufacturers' products, shall have equal or superior performance in the conditions anticipated for use of the product in this project, and shall be approved by the Engineer
- 33. OSHA: Occupational Safety and Health Act
- 34. Panel: with respect to circuit breaker and fuse power distribution centers, panel is equivalent to "distribution board", e.g., lighting panel; with respect to control panels, refers either to the entire control panel itself or to a steel plate used for mounting devices inside the control panel
- 35. Provide: Throughout the Specification, use of this term includes project administration, quality assurance, human resources, tools & equipment, logistics and scheduling, submittals of shop drawings & samples for approval, managing suppliers, purchasing, manufacturing, factory testing, release for shipment, packing, delivery, storage, submittal of coordinated & dimensioned installation drawings for approval, installation, surface preparation & finishes, site testing, startup & commissioning, on-site supervision by equipment manufacturers' representatives, spare parts & tools, Operations and Maintenance (O&M) Manuals, training, guarantees and warranties, other work described in individual Sections of the Specification, and the Contractor's duties, responsibilities, risks, and liabilities under the Contract.
- 36. Punch list: document containing detailed descriptions of non-conformities
- 37. Quality: conformance to specified requirements.
- 38. RMS: root mean square
- 39. Raceways: cable ladder and tray, conduit, duct, wireway, and associated boxes and fittings which enclose, support, and protect wires and cables
- 40. Shop drawings: a complete package of manufacturer's equipment drawings, bill of materials, catalog data sheets, performance curves, calculations, and other data provided to demonstrate conformance to the equipment specification
- 41. Substitution: an alternative, nonconforming product proposed by the Contractor in lieu of a specified, conforming product
- 42. Substantial Completion: an electrical system may be considered substantially complete when the equipment has passed the specified tests required prior to energization, has been energized, has passed the Electrical Acceptance Tests, and all related Specification requirements have been met except for well-defined minor items which, in the opinion of the Engineer, may be repaired or replaced prior to Final Acceptance without adversely affecting process performance.
- 43. Terminal box: an electrical enclosure containing labeled terminal blocks for connection of wiring
- 44. UL: Underwriters Laboratories, Inc.
- 45. VFC: variable frequency controller

- 46. VFD: variable frequency drive, the combination of VFC and inverter-duty motor that drive mechanical loads using the principle of variable frequency motor control
- 47. Wiring: conductors and connections to equipment terminals. 'Wiring' and 'cabling' shall be considered equivalent terms. Fiber optic cables shall be included in the scope of electrical wiring.

1.6 REFERENCE STANDARDS IN EFFECT

- A. Notwithstanding revision dates shown in this and other Sections of Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities" the codes and standards applicable to this project shall be those in effect when bids are submitted.

1.7 QUALITY ASSURANCE

- A. In consultation with the equipment and materials Suppliers, the Contractor shall prepare and submit a Compliance Statement as described in "SUBMITTALS" with each submittal requiring approval.
- B. The Engineer's review of a submittal shall not relieve the Contractor of any Contractor responsibilities under the Contract. Review of a submittal that is incomplete, or one that has nonconformities that are not described in the Compliance Statement, followed by the discovery of unapproved nonconformities, will result in replacement of the non-conforming items at no additional cost to the Owner. Substitutions require the approval of the Engineer as described in the General Conditions.
- C. Manufacturers of electrical equipment shall have quality certification to ISO 9000:2000 or an equivalent Quality Management System acceptable to the Engineer.
- D. Equipment, materials, and installation shall conform to NEC requirements and shall be NRTL-listed and labeled.
- E. On-site electrical acceptance testing shall be performed as specified in Part 3 of other Sections of the Specification.
- F. Manufacturers, manufacturer's representatives, subcontractors, supervisors, installers, and testing agencies shall have qualifications and experience as described in other Sections of the Specification. Qualifications and experience submittals for firms and individuals shall be submitted, re-submitted, or updated whenever requested by the Owner's Representative.

1.8 SAFETY IN THE WORKPLACE

- A. Electrical equipment and materials, and the Contractor's installation practices, shall conform to the following:
 - 1. Current edition of OSHA sections of the Code of Federal Regulations (CFR): Part 29 CFR 1910 for General Industry and Part 19 CFR 1926 for Construction Activities
 - 2. NFPA 70, the National Electrical Code
 - 3. Current edition of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces

- B. These regulations and standards impose obligations on equipment manufacturers to obtain NRTL certification, listing, and labeling to comply with OSHA (Occupational Safety and Health Act) and Department of Labor regulations.
- C. All electrical equipment for which NRTL test procedures have been established shall be certified, listed, and labeled, or otherwise determined to be safe for its intended use, by a NRTL. The absence of a specific reference to NRTL-listing in other Sections shall not relieve the Contractor of the requirement to provide NRTL-listed equipment, and to obtain certification as required by the AHJ in cases where NRTL listing and labeling is not a manufacturer's standard offering for a particular product.
- D. Equipment shall not be modified in any manner adversely affecting safety for the intended use, nor shall any equipment be modified on-site without the approval of the manufacturer.
- E. Equipment sound levels shall not exceed limits established by reference standards and local regulations. In the absence of reference standards and local regulatory requirements, sound pressure levels shall not exceed 85 dB (A) measured three feet from the equipment.
- F. Equipment with moving parts shall be fully guarded in compliance with OSHA rules and regulations.

1.9 INSPECTIONS BY THE AHJ

- A. The Contractor shall make arrangements for electrical inspection of the project by the AHJ. Upon completion of the work, final certificate of approval documents shall be submitted to the Engineer for forwarding to the Owner. This certificate shall be submitted prior to request for final payment. The Contractor shall pay all fees required for inspection.

1.10 WORKMANSHIP AND MATERIALS

- A. Materials and equipment shall be new and undamaged, shall be marked by the manufacturer, and shall be delivered to the construction site in the original factory packaging.
- B. Materials and equipment shall be installed in accordance with the Drawings, the Specification, the manufacturer's installation, operation, and maintenance instructions, and NECA installation standards that have been adopted by ANSI. In the event of apparent conflicts or discrepancies, the Engineer shall be informed of the apparent conflict or discrepancy in writing, and will instruct the Contractor how to proceed.

1.11 RESOURCES AND CONSTRUCTION SCHEDULE

- A. The Contractor shall provide sufficient resources, including qualified and experienced project managers, electrical engineers, superintendents, technicians, supervisors, electricians, tools and construction equipment to complete the electrical work in accordance with the activity durations and sequences shown on the Construction Schedule for this project.
- B. The construction schedule shall include the following activities and milestones, in realistic sequence, for each major item of electrical equipment in each building:
 - 1. Review of shop drawings

2. Approval of shop drawings (milestone)
 3. Factory testing
 4. Shipping
 5. Delivery to site (milestone)
 6. Concrete formwork ready for sleeves, openings, and inserts
 7. Room ceiling, wall, and floor finishing complete (ready for equipment installation)
 8. Equipment installation (including "remote" sites)
 9. Tests on completion of installation (prior to energization)
 10. Energization (milestone)
 11. Acceptance testing
 12. Functional testing
 13. Installation, acceptance testing, and functional testing and commissioning complete (milestone)
- C. The construction schedule shall include the following activities and milestones, in the following sequence, for electrical raceways and wiring in each building and structure:
1. Preparation of coordination drawings
 2. Materials delivery to site (milestone)
 3. Foundations ready for grounding electrode installation
 4. Imbedded raceway installation
 5. Room ceiling, wall, and floor finishing complete (ready for exposed raceway installation)
 6. Surface raceway installation
 7. Wire & cable installation
 8. Acceptance testing complete (milestone)

1.12 CONTRACT DRAWINGS

- A. The Electrical Drawings show scaled layouts of "basis of design" equipment but do not include "approved for construction" dimensions for equipment, which shall be based on approved equipment shop drawings.

1.13 COORDINATION OF ELECTRICAL WORK WITH OTHER TRADES

- A. Work under this Division shall be performed in conjunction with the work of other trades. Coordinate electrical installation work with the overall construction schedule. Examine the plans and specifications prior to commencement of work and become familiar with all phases of work involved prior to commencing installation work.
- B. The Contractor shall be responsible for coordinating dimensions of equipment and working clearances in accordance with the NEC, and in all cases shall bring to the attention of the Engineer any discrepancies on the plans and in the specifications prior to installation. Any work that installed without conformance to NEC requirements shall be removed and reinstalled at the Contractor's expense. The layout for sleeves, chases,

openings, etc., must be arranged prior to construction in order to prevent unnecessary cutting. Examine Architectural drawings for doors swings, countertop heights, built-in furniture and casework, and other factors affecting electrical outlet locations prior to roughing-in raceways, boxes, fittings, and outlets.

1.14 COORDINATION DRAWINGS

- A. Following approval of equipment shop drawings, the Contractor shall create dimensioned electrical equipment layout drawings for electrical and telecommunications rooms and areas, showing the relationships of approved electrical equipment with the building structural and architectural components, walls, floors, ceilings, doors, windows, louvers, access hatches, concrete equipment pads, anchors and bracing. One set of these Coordination Drawings shall be maintained at the construction site throughout the construction phase.

1.15 CODES AND STANDARDS

- A. All equipment and materials shall be manufactured, tested, and installed in accordance with the National Electrical Code (NEC) and local codes and standards, in accordance with the requirements of the AHJ.
- B. In addition, work shall be in accordance with the versions of the following referenced standards in effect at the time of bid opening:
 - 1. American Association for Laboratory Accreditation (A2LA) (establishes NRTL accreditation)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. Americans with Disabilities Act (ADA)
 - 5. Code of Federal Regulations (29 CFR 1903, 1910, and 1926)
 - 6. Factory Mutual Engineering & Research (FME&R)
 - 7. Illuminating Engineering Society of North America (IESNA)
 - 8. Institute of Electrical and Electronic Engineers (IEEE)
 - 9. Insulated Cable Engineers Association (ICEA)
 - 10. International Building Code
 - 11. International Organization for Standardization (ISO)
 - 12. National Electrical Contractors Association (NECA)
 - 13. National Electrical Manufacturers Associates (NEMA)
 - 14. National Fire Protection Association (NFPA)
 - 15. Occupational Safety and Health Act (OSHA)
 - 16. Underwriters Laboratory, Inc. (UL) and other NRTL standards and test procedures

1.16 HAZARDOUS AREAS

- A. Electrical equipment for use in hazardous areas shall be NRTL listed and labeled for the application. Equipment and installation shall be in accordance with NEC requirements for the hazardous area classification indicated on the Drawings.

1.17 SUBMITTALS

- A. In addition to conforming to the requirements described in the General Conditions, submittals shall conform to the following requirements.
- B. One complete shop drawing submittal is required for all of the electrical equipment described in single Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities" Sections of the Specification. Prerequisites for equipment shop drawing submittals, for example, Harmonics Analysis submittals associated with Variable Frequency Controllers and Coordination Studies associated with Switchgear, are described in each Section. Incomplete shop drawing submittals, and out-of-sequence shop drawing submittals, will be reviewed to the extent needed to determine incompleteness and out-of-sequence, and returned to the Contractor for re-submission.
- C. Compliance Statement: with each Shop Drawing submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.
- D. Submittal Format
 - 1. Each submittal shall be accompanied by a transmittal letter showing the submittal category and Specification Section reference number(s). Submittals shall be 3-hole punched and neatly bound in a 3-pin or 3-ring binder. Stapled bindings are not acceptable.
 - 2. Submittals shall have a complete Table of Contents with tabs corresponding to the Table of Contents headings.
 - 3. Submittal transmittal letters shall clearly identify the reason for submittal, e.g., for approval, as manufactured, or as-built / record.
 - 4. Each page of each submittal shall be numbered. Page numbers shall be listed on the Table of Contents. Content shall be printed on 8-1/2 x 11 inch paper, or 11 x 17 paper (folded). Larger size drawings shall be folded and placed in labeled individual clear plastic pockets.
 - 5. Product Data shall be clearly marked to show which items are proposed for this project. Information that does not apply to this project shall be crossed out.
- E. Submittal Categories
 - 1. Preconstruction Submittals, including proposed substitutions, supplier and manufacturer qualifications and experience, construction scheduling
 - 2. Shop Drawings, including equipment drawings with a complete bill of materials and supporting manufacturer's catalog data. One separate and complete shop drawing submittal for all of the equipment specified in each Section is required.
 - 3. Product Data, marked to indicate precisely which items are proposed for this project. One complete and separate Product Data submittal for all of the equipment and materials described in each Section requiring a product data

submittal, is required. See Submittals requirements in other Sections in Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities" to determine if Product Data is to be included in Shop Drawing submittals.

4. Samples, labeled by name, Specification Section and sub-clause, and mounted on sample boards
 5. Design Data, including manufacturer's design calculations, where specified
 6. Test Reports, including prototype tests, factory tests, field tests, acceptance tests, and functional tests. A test report is required for each specified test.
 7. Certificates, including seismic qualification certification, welding certificates, factory training certificates for manufacturer's representatives
 8. Manufacturer's Installation Instructions, including unloading, hoisting, rigging, short term storage, long term storage, method of field assembly, and other installation instructions
 9. Manufacturer's Field Reports, including inspections and training records
 10. Operation and Maintenance Manuals, including manufacturer's standard published literature and specially prepared descriptions of operation
 11. Closeout Submittals, including black line paper copy of Record Drawings marked in red illustrating changes during construction
 12. Spare Parts and Special Tools List
- F. In the absence of contradictory instructions in the General Conditions, Shop Drawings shall be marked with revision blocks to indicate status as follows:
1. FOR APPROVAL
 2. AS MANUFACTURED (incorporates Engineer's comments)
 3. AS BUILT / RECORD (incorporates on-site modifications)
- G. Record Drawings: Maintain a full size paper set of "black-line" working drawings throughout the project, and carefully record in red ink the locations and sizes of each major piece of electrical equipment, as well as manholes, handholes, and duct bank routing, to scale. Upon Substantial Completion of the work, deliver the marked-up set of prints to the Engineer. The Engineer reserves the right to withhold final payment until "As-Built" drawings are received.
- H. Operation and Maintenance Manuals: Provide copies of electrical Operation and Maintenance Manuals in conformance with the General Conditions. O&M Manuals shall be organized according to Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities" Section numbers. Each copy shall be bound in a durable, 3-ring hardback binder, with data sheets individually punched and reinforced to prevent tear out. Data sheets shall be grouped, and binder dividers shall be provided to match the Table of Contents. Each Manual shall have an identifying label on the spine and front cover and shall include the following:
1. List of all O&M Manuals in the front of each manual.
 2. Table of Contents for each manual and each binder
 3. Copy of each of the following:
 - a. Preconstruction Submittals
 - h. Shop Drawings

- i. Product Data
 - j. Design Data
 - k. Test Reports
 - l. Certificates
 - m. Manufacturer's Instructions
 - n. Manufacturer's Field Reports
 - o. Operation and Maintenance Data
 - p. Closeout Submittals
 - q. Spare Parts and Special Tools
 - r. Panelboard directories (as-built)
 - s. Copy of the Coordination Study
 - t. Copy of the Harmonics Analysis
- I. Spare Parts and Special Tools List: 90 days prior to the scheduled Substantial Completion date, submit a complete list of Spare Parts and Special Tools included in other Sections of Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities" to the Owner, and request a time and location for delivery of the Spare Parts and Special Tools to the Owner.
- J. Spare Parts and Special Tools List: 90 days prior to the scheduled Substantial Completion date, submit a complete list of manufacturer's recommended Spare Parts and Special Tools for equipment to the Owner, with prices firm for 90 days and estimated delivery dates.

1.18 OUTAGES

- A. Electrical outages: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service if required by the Specification.
- 1. Submit written requests to the Owner for approval of proposed electrical outages a minimum of 30 days in advance of proposed interruption of electrical circuits, with step-by-step sequence and schedule for proposed outage. If required to maintain critical processes in operation during an outage, submit proposed method of providing temporary electrical circuits and power supplies.
 - 2. Confirm approved interruption of electrical service one week in advance of Owner-approved date.
 - 3. Do not proceed with interruption of electrical service without written approval from the Owner.

1.19 TEMPORARY LIGHTING AND POWER

- A. Refer to the General Conditions.
- B. The Contractor shall provide all temporary electric services for power and lighting including panels, feeders, lighting, outlets, branch circuits, etc.
- C. The Owner's electrical power shall not be used without permission of the Owner.

- D. All temporary work shall be in accordance with the NEC, OSHA, and NFPA safety requirements and shall be completely removed upon completion of the project.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. Provide equipment and materials in compliance with other Sections of Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities". The requirements in this Section apply to all Sections in Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities".

2.2 ELECTRICAL IDENTIFICATION

- A. Electrical equipment, raceways, boxes, fittings, wires and cables shall be marked in the field in accordance with Division 26 Section "Identification for Electrical Systems".

2.3 ELECTRICAL ENCLOSURES

- A. In the absence of other specified NEMA enclosure ratings in other Sections of the Specification, and where cross-referenced in other Sections of Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities" electrical enclosures shall have degree of protection ratings suitable for the intended application (e.g., watertight, dust-tight, explosion-proof) and environmental conditions.
- B. Electrical enclosures shall have degree of protection ratings suitable for the intended application (e.g., watertight, dust-tight, explosion-proof) and environmental conditions. Electrical equipment enclosures shall at a minimum have the following ratings and materials of construction:
 - a. Indoor enclosures: NEMA 12 in clean and dry electrical rooms and control rooms. All other areas, except Hazardous (Classified) locations, shall be NEMA 4X stainless steel.
 - b. Outdoor enclosures: NEMA 4X stainless steel or FRP, except Hazardous (Classified) locations.
 - c. Hazardous (Classified) areas: Epoxy powder-coated cast aluminum NEMA 7 and/or 9 with UL listing for the hazard classification.
- C. Where different enclosure ratings and enclosure materials are specified in other Sections of the Specification, the Contractor shall submit a written request for clarification of the intent of the Specification to the Engineer.
- D. For motor enclosure requirements, refer to Division 26 Section "Common Motor Requirements".

2.4 ELECTROMAGNETIC INTERFERENCE

- A. Power conversion equipment, including variable frequency controllers, battery-powered inverters, computer power supplies, frequency converters, and Uninterruptible Power Supplies, shall be fitted with EMI (electromagnetic interference), RFI (radio frequency interference) and telephone interference filters to limit interference effects on other equipment in the area in accordance with IEEE standards and recommendations applicable to the equipment.

2.5 DISSIMILAR METALS

- A. Dissimilar metals shall not be connected, spliced, or joined except where specifically approved in writing by the Engineer. Copper busbars, aluminum busbars, and copper-to-aluminum busbar connections shall be tin-plated at joints and at cable lugs. Bolted electrical conductor connections shall be made with [silicone-bronze] [grade 3 or better plated steel] bolts, nuts, and washers. Belleville washers & tin-plated flat washers shall be used at aluminum-to-copper and aluminum-to-aluminum busbar joints.

2.6 WARRANTIES

- A. Warranties for equipment and materials shall conform to the General Conditions.
- B. Provide an on-site parts and labor warranty for a minimum period of one year after Substantial Completion for all equipment and materials. In cases where the manufacturer offers a longer warranty period, the longer warranty period shall apply as described by the manufacturer.
- C. All components of electrical systems that are not fully functional at the time of Substantial Completion shall have warranties extended to provide minimum one year coverage of fully operational equipment unless otherwise approved by the Owner's Representative.

PART 3 - EXECUTION

3.1 DELIVERY AND HANDLING

- A. Equipment delivered to site shall be handled in accordance with manufacturer's recommendations by experienced riggers, crane operators, and fork lift truck operators.

3.2 STORAGE AND PROTECTION OF EQUIPMENT

- A. All electrical equipment to be used in construction shall be properly stored and protected against the elements. General construction materials shall be stored in covered trailers. Switchgear, unit substations, motor controllers, panelboards, emergency lighting, solid state equipment, engine generator shall be stored in a clean, dry, indoor location, under cover, until the building is weathertight and the area where the equipment is to be installed has been completed to the satisfaction of the Engineer, including completion of overhead work by other trades.
- B. Long term storage instructions of the manufacturer shall be followed.
- C. Equipment with anti-condensation heaters shall have the 120VAC anti-condensation heaters energized from temporary 120VAC supplies as soon the factory packaging has been opened.
- D. Equipment enclosures exposed to construction damage such as paint spots, spackling, waterproofing, insulation etc. shall be covered and protected against damage.

3.3 INSPECTIONS PRIOR TO COVERING-UP

- A. Raceways embedded in concrete or otherwise concealed shall be inspected in the presence of the Owner's Representative prior to placement of concrete. Sufficient time shall be allowed to make corrections if required.

3.4 ON-SITE INSPECTIONS AND NONCONFORMITIES

- A. Equipment shall be inspected on delivery to site for physical damage and for compliance with the Specification and approved equipment shop drawings.
- B. Installed equipment, raceways, and wiring shall be inspected on completion of installation for compliance with the Specification and approved installation drawings.
- C. A Punch List will be prepared by the Owner's Representative during inspections and testing, and issued to the Contractor for corrective action.
- D. Repairs, replacement, and other corrective action that requires de-energizing any part of the Electrical Power Distribution and Control System shall be completed prior to the scheduled date for Substantial Completion of the project.

3.5 PENETRATIONS AND SEALING

- A. Sleeves and rectangular openings shall be provided for raceways provided under this Contract, and for raceways for future equipment where future equipment is shown on the Drawings. Sleeves and rectangular openings for the passage of raceways and conductors shall be sealed after the raceways and conductors have been installed. Spare sleeves and rectangular openings shall also be sealed.
- B. Penetration of Waterproof Construction: Coordinate the work to minimize penetration of waterproof construction, including roofs and exterior walls. Where penetrations are necessary, provide sleeves and sealing fittings to make each penetration watertight. Conduit sleeves and openings shall be sealed watertight with mechanical seals. Watertightness shall not rely on caulking.
- C. Penetration of Fire-Rated Construction: Sleeves and openings in fire-resistant walls and floors for electrical raceways, wires, and cables shall be sealed after installation of the raceways, wires, and cables with NRTL-certified fire penetration seals, sealant, and fire-rated foam filler products to the same degree of fire resistance (e.g., 1, 2, or 4 hours) as the adjacent walls and floors, and to the satisfaction of the AHJ. Where both fire sealing and water sealing is required, mechanical seals with NRTL-listed fire-resistant properties shall be used. Fire sealants shall be compatible with the cable jacket and wire insulation materials. Manufacturer's certification of compatibility shall be provided at the request of the Engineer. For additional requirements, refer to Division 26 Section "Raceways and Boxes for Electrical Systems".

3.6 ALTERATIONS AND REMOVAL OF EXISTING WORK

- A. Conform to the General Conditions.
- B. Where the work specified under this Division connects to the existing electrical systems, the Contractor shall perform all necessary alterations to the existing work as required.
- C. All work performed on the existing electrical systems shall be in accordance with the applicable provisions of the Specification. Visit the project site prior to submitting bids and examine the conditions in which work will be performed. Carefully document all existing conditions pertaining to removal and demolition work.
- D. Contractor shall make connections to existing equipment where indicated on the Drawings.
- E. All existing electrical materials not reused under this Division, and not indicated for handover to the Owner, shall become the property of the Contractor and shall be expeditiously removed from the project site.

- F. While performing connections and alterations to existing electrical work, the Contractor shall take special care to protect all existing equipment from dirt, debris and damage. Damaged equipment shall be replaced at no additional cost to the Owner.
- G. All removal work shall be performed in a neat and workmanlike manner and shall be executed with the least possible disturbance to the building and tenants. The scheduling of all removal work shall be coordinated with other trades and with the Owner's schedule and operation of the building.
- H. Where removal work is performed, the Contractor shall repair all building surfaces damaged by such work. Cut back embedded conduits to 2 inches minimum below finished face of walls, floor, and ceilings, and fill in holes with appropriate patching material. Repair, re-tile, replace (in the case of ceiling panels) or re-paint to match existing adjacent surfaces.

3.7 ELECTRICAL SAFETY AND TEST EQUIPMENT

- A. Maintain the following test instruments and calibration certificates less than 12 months old on-site as a minimum:
 - 1. True RMS digital volt-ohm meter with resistance scale
 - 2. Clip-on ammeter with range from 1 to <insert maximum amps> amps
 - 3. 1000V DC battery-powered megger insulation tester
- B. Provide electrical safety equipment, including personal protective equipment, hot sticks, HV gloves, electrical blankets, test instruments, lighting, ventilation, and instructions in the use of safety equipment, and perform the work under this Contract in accordance with applicable safety rules and regulations. The Contractor's attention is directed to safety issues related to confined spaces as defined in OSHA regulations.
- C. One numbered safety lockout padlock with an 'unlawful-to-duplicate' unique key shall be provided for each motor controller. Safety lockouts shall be used during testing and commissioning, and shall subsequently be handed over to the Owner in a lockable sheet metal key cabinet. The safety lockout padlock supplier shall be a specialist supplier with a registered key program.

3.8 CLEANING AND PAINTING

- A. Conform to the General and Special Provisions.
- B. After installation and wiring work is completed, all dust and debris shall be removed from the interior and exterior of each electrical equipment enclosure and motor by vacuum-cleaning with circuits de-energized. Do not use compressed air for cleaning. Vacuum cleaner wands and brushes shall be non-conducting. Anti-static protection shall be provided for static-sensitive devices.
- C. Clean and remove all rust, scale, oil, grease, and dirt from panelboard enclosures, conduits, pull, junction and terminal boxes, fittings and hangers, leaving surfaces in condition for final surface preparation and painting under Division "Finishes".
- D. All ferrous materials that are concealed, or exposed in unfinished areas, including fittings, hangers, junction, pull and terminal boxes, that are not plated or painted with a factory-applied finish, shall be painted under this Section with one coat of zinc-chromate primer and one finish coat of paint approved by the Engineer. Nonferrous materials shall be cleaned only and left unpainted.

- E. Equipment furnished with a factory finish coat shall have finish carefully touched-up where it is scratched or otherwise damaged. Touch-up work shall be match the color and type of the original finish.

3.9 INSPECTION AND TESTING ON-SITE

- A. The Contractor shall hire a NETA-certified or NICET-certified specialist electrical testing firm to perform on-site inspection and electrical testing.
- B. Perform Electrical Acceptance Tests in accordance with NETA Acceptance Testing Specifications as described in Part 3 of each Section of Division 26.
- C. Submit manufacturer-endorsed field test data sheets & procedures for approval, test equipment and materials on-site prior to site visit by manufacturer's factory-trained representative, test equipment on-site under the supervision of the Owner's Representative and the equipment manufacturer's factory-trained representative(s), and submit manufacturer's statement of acceptance of installation prior to energization of equipment. Invite the Engineer and Owner's Representatives to witness field testing.
- D. Electrical equipment shall not be energized without the approval of the Engineer.
- E. A complete certified electrical test report shall be compiled by the electrical testing firm, checked for completeness, and submitted for the record.
- F. The Contractor shall notify all parties whose presence is necessary for the test; and in all cases, the Engineer shall be notified at least two weeks prior to the actual test.

3.10 ELECTRICAL POWER DISTRIBUTION SYSTEM FUNCTIONAL TESTS

- A. Conform to the General Conditions.
- B. After testing and commissioning for equipment has been completed, the following functional tests of the electrical power distribution and control system shall be carried out by the Contractor's specialist electrical testing firm in the presence of the Engineer or Owner's representative:
 - 1. Using a precision laboratory voltmeter with certified 0.1 % accuracy, record incoming supply voltages for each switchgear lineup, switchboard, and motor control center in the presence of the Engineer's Representative. Measurements shall be taken under no-load and normal load conditions. Readings which indicate more than 1% voltage difference between phases will require corrective action.
 - 2. Using a precision harmonic voltage and current measuring and recording instrument, measure the total harmonic voltage distortion at each motor control center and switchboard main busbars (through the normal metering test blocks). Measurements shall be taken at two or three different operating load conditions determined by the Engineer.
- C. Additional testing shall be carried out where recommended by equipment suppliers or requested by the Engineer.

3.11 LOAD BALANCING

- A. Single phase circuits in single and three-phase circuit breaker distribution boards and panelboards shall be balanced initially based on the load calculations. Load currents shall be measured under actual operating conditions, and under conditions described by the

Engineer. Circuiting shall be re-arranged as necessary to obtain current balancing within 10% on each busbar under normal operating conditions.

3.12 DISTURBING EXISTING PAVEMENT AND LANDSCAPING

- A. Where cutting existing pavement and disturbing existing landscaping is necessary to perform work included in this Contract, the Contractor shall employ professional subcontractors to restore the appearance of disturbed areas to their original condition.

3.13 DEMONSTRATION AND TRAINING

- A. Conform to the General Conditions.
- B. Upon completion of all work furnished and installed under Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities", instruct and train the Owner's representatives in the operation and maintenance of all the various apparatus and equipment to the complete satisfaction of the Engineer. Training shall be as specified in each Section of Divisions 26, "Communications", "Electronic Safety and Security" and "Utilities" and shall start when the completed systems have been put in operational condition and tested as specified. A complete Training Course syllabus together with copies of the training materials shall be submitted with the Contractor's proposed schedule for instruction and training.
- C. Provide classroom and on-site training of the Owner's staff by an authorized representative of the equipment manufacturer during commissioning of the following electrical equipment:
 - 1. Motor control centers & auxiliary switchboards: 1 day each
 - 2. Variable frequency controllers: 1 day each size and type
 - 3. Uninterruptible power supplies (UPS): 1 day for each size and type
 - 4. Control panels and control consoles: 1 day each
 - 5. Provide 3 days of on-site classroom training in the theory and application of protection relays, circuit breaker electronic trip units, and metering equipment supplied for this project. Demonstrate how to calibrate each meter, and how to adjust settings for each overcurrent protection device.
- D. Submit qualifications and experience of manufacturer's proposed training personnel for approval.
- E. Additional requirements for training are described in other Sections of the Specification.

END OF SECTION

SECTION 26 00 20

COMMON MOTOR REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide electric motors in conformance with this Section for electric motor-driven equipment specified in other Sections of the Specification.
- B. This Section describes requirements for horizontal and vertical 3-phase squirrel cage induction motors up to nominal 500 HP in NEMA standard frame sizes.

1.2 RELATED DOCUMENTS

- A. Drawings and General Conditions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.
- B. Submersible pump motor, hermetic compressor motor, valve actuator motor, gate actuator motor, and single phase motor requirements shall be specified in other Sections of the Specification.

1.3 DEFINITIONS

- A. The following definitions apply to this Section:
 - 1. ABMA: American Bearing Manufacturers Association
 - 2. AFBMA: Anti-Friction Bearing Manufacturers Association (former name of ABMA)
 - 3. BHP: brake horsepower
 - 4. HP: horsepower
 - 5. ODP: Open drip-proof
 - 6. ODP FG: Open drip-proof, fully guarded
 - 7. PWM: pulse-width modulated
 - 8. TEFC: Totally enclosed fan-cooled
 - 9. TENV: Totally enclosed non-ventilated
 - 10. Vpeak: single amplitude zero-to-peak line-to-line voltage
 - 11. Vrated: nameplate line-to-line voltage
 - 12. VFC: variable frequency controller
 - 13. VFD: combination of variable frequency controller and motor

1.4 CODES AND STANDARDS

- A. Equipment and installation shall be in accordance with the latest revisions of the following codes and standards:
 - 1. NEMA Standard MG1-2003 (Rev. 1 – 2004) Motors and Generators
 - 2. ANSI / IEEE Standard 112 Standard Test Procedure for Polyphase Induction Motors and Generators

3. IEEE 841 Standard for Petroleum and Chemical Industry - Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp)
4. NEC: National Electrical Code (NFPA 70)
5. Underwriters Laboratories, Inc. (UL)

1.5 QUALITY ASSURANCE

- A. Motors shall be designed, manufactured, and tested in accordance with the Codes and Standards referenced in this Section.
- B. Motor manufacturers shall have quality certification to ISO 9001:2000, or an equivalent quality management system acceptable to the Engineer.

1.6 SUBMITTALS

- A. Motor submittal data shall be included with the mechanical equipment shop drawing and product data submittals.
- B. For variable frequency drive applications, submit a Certification Letter as described in INVERTER DUTY MOTORS. For variable frequency drive applications in Hazardous (Classified) Locations, the certification letter shall include a statement of motor conformance to NEC Article 500 temperature rise limits for the anticipated hazardous gasses or dusts, following the recommendations in NEMA MG1-2003 31.1.4. Submittals for variable frequency drive applications without the certification letter will be considered incomplete.
- C. The motor portion of shop drawing and manufacturer's product data submittals, for mechanical equipment specified in other Sections, shall include the following:
 1. Motor assembly drawings with the following information:
 - a. Enclosure type with degree of protection (IP rating)
 - b. Materials of construction of housing, stator, rotor, fan, fan guard
 - c. Bearing types, bearing construction, shields and seals
 - d. Lubrication system
 - e. Location of lubrication fittings
 - f. Location and type of breathers and drains for totally enclosed motors
 - g. Internal and external coatings
 - h. Direction of rotation
 - i. Electrical wiring diagrams for connection of windings and accessories
 2. Motor specification data sheets with the following motor nameplate information:
 - a. Manufacturer's type and frame designation
 - j. Horsepower output
 - b. Time rating
 - c. Maximum ambient temperature for which the motor is designed
 - d. Insulation system designation
 - e. Full load RPM

- f. Voltage(s)
 - g. Frequency
 - h. Number of phases
 - i. Full load amperes
 - j. NEMA Code Letter for locked-rotor amperes (or locked rotor amperes)
 - k. NEMA nominal efficiency
 - l. Motor service factor for sine wave applications
 - m. Designation “Thermally Protected” or “OVER TEMP PROT – [type number per NEMA MG1]” (as applicable)
 - n. ABMA bearing ID number(s)
 - o. NRTL and listing for Hazardous (Classified) Areas (explosion-proof motors only)
3. Inverter Duty motor data sheets shall include the following additional information:
- a. Motor service factor for PWM variable frequency drive applications
 - b. Motor winding insulation impulse voltage rating
 - c. Bearing insulation
 - d. Shaft grounding details
4. Submittals shall include information about all specified motor options, with sufficient detail to demonstrate that the motor is suitable for the drive application, including but not limited to the following:
- a. Winding over-temperature protection devices
 - b. Anti-condensation heaters
 - c. Condensation drains (totally enclosed motors only)
 - d. Shaft and bearing seals
 - e. Anti-backspin ratchets
 - f. Thrust bearings
 - g. Oil lubrication accessories
 - h. Hollow or solid shaft details
 - i. Coupling and drive pulley details
 - j. Mounting base details
5. Factory Test Reports
6. Manufacturer’s Installation Instructions: including manufacturer’s shipping, receiving, handling, rigging, storage and setting instructions, recommendations, cautions, and warnings.
7. Field Test Reports

PART 2 - PRODUCTS

2.1 DRIVE APPLICATION

- A. Motors shall be selected by the driven equipment manufacturer for the drive application, and for operation within the motor nameplate horsepower rating without applying the service factor.
- B. Motors shall have output torque characteristics, direction of rotation, rotational speed, dimensions, bearings, and accessories suitable for the drive application. Motor output shaft dimensions and keyway shall be suitable for connection to the driven equipment coupling.
- C. Motors shall be capable of successfully accelerating inertial loads tabulated in NEMA MG1-1998 Section 12.54 without injurious heating. In cases where the actual load inertia exceeds, these values, the driven equipment manufacturer shall select a larger motor capable of successfully accelerating the inertial load without injurious heating.
- D. Motor continuous output horsepower shall be limited to the 1.0 service factor rating.

2.2 VOLTAGE RATINGS

- A. Motors ½ HP and larger shall be 460 V three phase 60 Hz, unless otherwise indicated.
- B. Motors 1/3 HP and smaller shall be 120 V single phase 60 Hz, and shall be suitable for the drive applications described in other Sections.

2.3 EFFICIENCY

- A. Motors other than explosion-proof motors shall have nominal efficiencies in accordance with NEMA MG1-2003 Table 12-12 Full-Load Efficiencies for NEMA Premium™ Efficiency Electric Motors Rated 600 Volts or Less (Random Wound).
- B. Motor efficiencies shall be determined in conformance with IEEE 112 Method B.

2.4 STATOR WINDINGS AND INSULATION

- A. Motors shall have moisture-resistant Class F insulated copper stator windings. Motors shall be designed for both full-voltage and reduced-voltage starting. Additional requirements apply to VFD applications, refer to INVERTER DUTY MOTORS.
- B. Motors shall have 1.15 minimum service factor (on sine wave power), and Class B temperature rise when operated at rated HP at 1.0 service factor.
- C. Motors located outdoors and in unheated indoor areas shall have encapsulated or sealed windings capable of passing the conformance tests in NEMA MG1-2003 12.62. Alternatively, 120 VAC anti-condensation heaters shall be provided.
- D. Non-inverter-duty motors shall have minimum peak impulse voltage rating $V_{peak} = 1000$ V, with rise time as short as 2 microseconds, in accordance with NEMA MG1-2003 30.2.2.8.
- E. Motors 500 HP and smaller shall have stall times of 12 seconds minimum when initially at normal operating temperature, in conformance with NEMA MG1-2003 12.49.

2.5 INVERTER DUTY MOTORS

- A. Motors operating on variable frequency controllers shall be “inverter duty” type, with minimum peak impulse voltage rating $V_{\text{peak}} = 3.1$ times V_{rated} with rise time as short as 0.1 microseconds, and in accordance with NEMA MG1-2003 31.4.4.3 recommendations, to provide long insulation life when operating on PWM variable frequency controller output voltage waveforms.
- B. Inverter duty motor bearings shall be insulated on one or both ends to prevent bearing element damage from stray electrical currents, as described in NEMA MG1-2003 31.4.4.3. Provide motor shaft grounding brush(es) to drain stray rotor currents to the motor electrical equipment grounding conductor connection point.
- C. Inverter duty motors shall be fitted with winding over-temperature accessories as described in WINDING OVERTEMPERATURE PROTECTION.
- D. For each variable frequency drive application indicated, provide a Certification Letter from the motor manufacturer stating that the motor, and in particular the peak impulse voltage insulation rating, bearing insulation, and shaft grounding method, is suitable for operation on the variable frequency controller proposed for the project, naming the specific VFC manufacturer and catalog number, and including a statement that the variable frequency drive motor branch circuit length and conductor size has been taken into consideration. Include available “skip-frequency” information and VFC setting recommendations with the Certification Letter.

2.6 DEGREE OF PROTECTION

- A. Motors housings shall have enclosures with degree of protection ratings as specified in the mechanical equipment Sections of the Specification.
- B. In the absence of motor enclosure degree of protection ratings specified in other Sections of the Specification, the following degrees of protection shall apply:
 - 1. Outdoor Areas: severe-duty TEFC or TENV to IEEE 841.
 - 2. Corrosive and Chemical Areas: severe-duty TEFC or TENV to IEEE 841.
 - 3. Clean, Dry, Indoor Areas (not including Process Areas): ODP FG (IP32).
 - 4. Indoor Process Areas (including rooms containing pumps and process equipment): TENV or TEFC (IP55)
 - 5. Hazardous (Classified) Locations: explosion-proof and dust ignition-proof TEFC or TENV severe duty to IEEE 841, NRTL-listed and labeled for the hazardous location classification, and conforming to NEC Article 500 requirements.
- C. Motors located in Hazardous (Classified) Locations and operating on VFC's shall be certified by the equipment supplier and the motor manufacturer to meet NEC requirements for maximum temperature limits for the Hazardous (Classified) Location indicated when operating on the VFC at the specified maximum ambient temperature. Submit Certification Letter as described in SUBMITTALS.

2.7 MOTOR FRAMES

- A. Motor frames shall be NEMA standard sizes. Open motors over 5 HP, enclosed motors (not severe duty) over 2 HP, severe-duty and explosion-proof motors shall have cast iron frames.

2.8 AMBIENT CONDITIONS

- A. Motors shall have NEMA standard horsepower ratings for continuous duty under the following environmental conditions:
 - 1. Ambient Temperature: -25 to +40 deg. C.
 - 2. Altitude: Not exceeding 3300 feet (1000 m).
- B. Motors shall be suitable for any unusual service conditions indicated on the Drawings, or in other Sections of the Specification.

2.9 COOLING

- A. Motors shall be air-cooled, with internal or external fans. Variable speed motors shall be suitable for operation over a 4:1 speed range without separate method of cooling.
- B. Motors with speed ranges greater than 4:1 shall be fitted with separate electric motor-driven forced-air cooling to prevent overheating when running continuously at the lowest specified operating speed.

2.10 INRUSH CURRENT

- A. Motors over 20 HP shall have inrush current equivalent to NEMA Code G, or lower.

2.11 MAXIMUM SPEED

- A. Unless otherwise indicated, motor synchronous speeds shall not exceed 1800 RPM.

2.12 NAMEPLATES

- A. Provide stainless steel motor nameplates with engraved or stamped markings in accordance with NEMA standards, and including the information specified in SUBMITTALS.

2.13 ROTORS

- A. Rotors shall be aluminum or copper, designed for 125% rotational speed in either direction without distortion or damage, and shall be statically and dynamically balanced as described in VIBRATION LIMITS.

2.14 BEARINGS

- A. Motors shall have re-greasable anti-friction bearings as recommended by motor manufacturer for the application. Oil lubricated ring, sleeve, and plate bearings shall be permitted only for special applications as specified in the mechanical equipment Section of the Specification, and for vertical hollow-shaft motors as described below.
- B. Motors shall have radial bearings and thrust bearings designed to carry all of the loads imposed on the motor in service.
- C. Grease fittings and either drain plugs or grease pressure relief fittings shall be provided for each bearing.
- D. Anti-friction bearings shall have minimum calculated ABMA L-10 life of 100,000 hours for flexible direct-coupled applications, and minimum calculated ABMA L-10 life of

26,280 hours in belt drive applications. Provide motors with longer calculated bearing life where indicated in other Sections of the Specification.

- E. Vertical hollow-shaft motors shall be equipped with oil lubricated spherical roller thrust bearings with oil reservoirs and visual indication of oil level, and lower grease lubricated radial guide bearings. Sufficient oil shall be provided to fill the oil reservoir(s) plus any additional oil required for one refilling. The oil shall be in a properly identified container. Running fit adjustment shall be provided by means of a lockable nut at the top of the shaft. Provide anti-backspin ratchets to prevent reverse rotation.

2.15 VIBRATION LIMITS

- A. For standard motors, unfiltered motor vibration velocities shall not exceed the limits in NEMA MG1 Table 7-1 when measured in accordance with Part 7 of NEMA MG1.
- B. For severe duty motors, unfiltered motor vibration velocities shall not exceed the limits in IEEE Standard 841-2001 6.9.
- C. Special motor vibration limits, when required for the application, shall conform to the requirements of the manufacturer of the driven equipment.

2.16 TERMINAL BOXES

- A. Open motor terminal boxes shall be gasketed ferrous metal or cast iron, with diagonally split bolted cover.
- B. Enclosed motor terminal boxes and covers shall be cast iron, with diagonally-split bolted cover, gaskets or O-rings to IP55, and NPT-threaded conduit entry.
- C. Terminal boxes shall be suitable for top, bottom, drive end or non-drive end conduit entry by removing terminal box mounting bolts and rotating terminal box in 90 degree increments. Coordinate conduit entry quantities and sizes with motor branch circuit conduit sizes.
- D. Provide grounding lug inside terminal box for NEC-sized equipment grounding conductor.
- E. Terminal boxes shall be suitable for the conduit and wire sizes shown on the Drawings.

2.17 PROTECTION AGAINST CONDENSATION

- A. Totally enclosed motors shall be fitted with breathers and condensation drains.
- B. Provide anti-condensation heaters for motors located outdoors. The requirement for anti-condensation heaters may be waived by the Engineer if the motor is manufactured with a sealed insulation system unless the equipment manufacturer recommends anti-condensation heaters for the drive application.

2.18 WINDING OVER-TEMPERATURE PROTECTION

- A. Motor winding over-temperature shall be provided for motors in variable frequency drive applications, and where specified in the mechanical equipment Sections of the Specification.
- B. Motor winding over-temperature devices shall be as follows:
 - 1. Motors 300 HP and smaller: a minimum of three normally closed winding over-temperature switches, one in each phase. Switches shall open at the permissible

temperature rise for the insulation class in accordance with NEMA MG1-2003 31.4.1.2.

2.19 REQUIRED ACCESSORIES

- A. Belt-drive motor applications: adjustable motor mounting bases.
- B. Motors shall include lifting lugs.

2.20 FACTORY TEST REPORTS

- A. Motors through 200 HP: routine test, reported on IEEE 112 Annex B routine test form.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors in accordance with the motor and mechanical equipment manufacturers' recommendations.

3.2 OVERLOAD RELAYS

- A. Set motor overload protection in accordance with motor, motor controller, and power factor correction capacitor manufacturers' recommendations.

3.3 VARIABLE SPEED SKIP FREQUENCIES

- A. For each motor operating on a variable frequency controller, advise the VFC supplier which critical frequencies need to be skipped to avoid excessive mechanical vibration during variable speed operation.

3.4 FIELD TESTING

- A. Perform motor electrical acceptance testing in accordance with NETA ATS 7.15 Rotating Machinery / 1. Motors / 1. AC Motors / 1. Visual and Mechanical Inspection and 2. Electrical Tests – Induction Motors.
- B. Submit motor field test reports with the mechanical equipment field test reports, and incorporate test data into the mechanical equipment O&M Manuals.

END OF SECTION

SECTION 26 00 30

HEAT TRACING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete pipeline heat tracing system as shown on the Drawings and specified herein.
- B. This Section describes requirements for a complete electrical heat tracing system including heat tracing panelboard, temperature self-regulating polymer heat trace cables for insulated pipeline applications, line voltage thermostat controls, cold junction boxes, cable splices, end-of-line indicator lights, and related accessories.

1.2 RELATED DOCUMENTS

- A. Division "Process Integration" Section "Process Piping and Equipment Heat Tracing" for process requirements.
- B. Division "Plumbing" Section "Heat Tracing for Plumbing Piping"
- C. Division "Heating, Ventilating and Air Conditioning (HVAC)" Section "Heat Tracing for HVAC Piping"
- D. Division "Electrical" Section "Panelboards" for power supply circuit breaker requirements.
- E. Division "Electrical" "Grounding and Bonding for Electrical Systems".

1.3 DEFINITIONS

- A. Refer to the definitions in Division electrical" Section "Electrical".

1.4 QUALIFICATIONS

- A. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer. The manufacturing company shall be listed in a published NRTL directory of companies offering NRTL-listed and labeled products. All components of the heat tracing system shall be manufactured by one company.
- B. Testing Firm Qualifications: An independent firm, with experience and capability to conduct specified tests, and is a member company of NETA or is an NRTL as defined by OSHA in 19 CFR 1910.7, acceptable to the AHJ.
- C. Testing Firm's Field Supervisor Qualifications: person currently certified by NETA or NICET to supervise on-site testing specified in Part 3.

1.5 REFERENCE STANDARDS

- A. Factory Mutual Research Corporation
- B. IEEE 515-1997 IEEE Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications 1997
- C. UL 746B Standard for Polymeric Materials; Long Term Property Evaluations

1.6 PROJECT CONDITIONS

- A. Corrosion Resistance: Heat trace cable jackets, wire mesh jackets, electrical boxes, thermostats, indicator lights, heat shrink tubing, cable-to-box connectors, cable ties, and other heat tracing components shall be resistant to solvents and corrosive effects likely to be encountered in the application, including waste effluent, sodium hypochlorite and ultraviolet light.

1.7 SUBMITTALS

- A. Shop Drawings: Include the following:
 - 1. Compliance Statement: as described in Division "Electrical" Section "Electrical".
 - 2. Product Data: Manufacturer's technical data sheets for each heat trace component proposed to be installed for this Project.
 - 3. Shop Drawings: Specially prepared power and control wiring diagrams showing factory and field wiring, and details for attaching heat tracing components to mechanical piping.
- B. Coordination Drawings: Submit scaled plans, sections, elevations, details, and schedules showing heating cable layout with heat trace panelboard(s), thermostats, cold junction boxes, splices, taps, and panelboard schedules.
- C. Field Test Reports: Record and interpret test results for compliance with specified performance requirements.
- D. Qualification Data: For testing firm and testing firm's field supervisor.
- E. Installation Instructions: As published by manufacturer.
- F. Operation and Maintenance Manual: For electric heat tracing components, to include in Operation and Maintenance Manuals specified the General Conditions.
- G. Warranties: Special warranties specified in this Section.

1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain heat tracing cables and accessories from a single qualified manufacturer.
- B. Unit Responsibility: The heat tracing system manufacturer shall be responsible for the design of the entire heat tracing system described in this Section.

- C. Comply with NEC requirements.

1.9 COORDINATION

- A. Coordinate layout and installation of electric heating cables and system components with mechanical piping construction specified.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

- A. The heat tracing design shown on the Drawings is based on Raychem Corporation.
- B. Heat tracing systems by other specified manufacturers will be acceptable on the following conditions:
 - 1. The Contractor and the manufacturer shall re-design the heat tracing system for the specified performance requirements, and adjust the quantity and conduit and wire sizes for branch circuits, the heat trace cable lengths, the quantity and trip ratings of branch circuit breakers, and the quantity and location of cold junction boxes, to suit the proposed alternate manufacturer's products.
 - 2. No delays to completion of the Project.
 - 3. No additional cost to the Owner.

2.2 MANUFACTURERS

- A. Provide products by Raychem Corporation or one of the following manufacturers:
 - 1. Nelson Heat Tracing Systems
 - 2. Chromalox, Wiegard Industrial Division, Emerson Electric Company
 - 3. Or approved equal.

2.3 NRTL CERTIFICATION

- A. Heat trace cable and electrical components shall be NRTL listed and labeled in accordance with NEC Article 100, and OSHA requirements in 29 CFR 1910.7

2.4 ELECTRICAL RATINGS

- A. Power Supply Voltage: 120V, 1 phase or 208/120V, 3 phase, 4 wire, 60 Hz.
- B. Branch circuits: 120V single phase, 15 or 20 amp circuit breakers with 30 mA ground fault trip

2.5 MATERIALS OF CONSTRUCTION

- A. Heat Tracing Cables:
 - 1. Core and buswires: Nickel-plated copper wires, minimum #16 AWG, configured as parallel buswires that provide constant voltage across a temperature self-regulating heating element
 - 2. Self-Regulating Heating Element: cross-linked polymer or self-regulating polymeric fiber that varies heat output in response to heating element temperature

3. Inner Jacket: Fluoropolymer or similar thermoset insulation
4. Overbraid: Woven [tinned copper] [stainless steel] sheath, 100% coverage, connected to branch circuit equipment grounding conductor
5. Outer Protective Jacket: Thermoset extrusion with ultraviolet inhibitor

2.6 ENCLOSURES

A. Electrical Enclosures:

1. Heat Trace Panelboards: in accordance with NEMA 250. Materials of construction shall be as specified in Division "Electrical" Section "Panelboards".
2. Thermostat housings, cold junction boxes, and other electrical enclosures shall be cast aluminum with plastic coating, zinc-coated malleable iron with plastic coating, stainless steel, or fiberglass-reinforced plastic, rated NEMA 4X in accordance with NEMA 250.
3. Covers: gasketed and fastened with brass or stainless steel screws.
4. Electrical enclosures shall be suitable for outdoor use in the ambient conditions at the installation site.
5. Condensation inside electrical enclosures shall be prevented by one or more of the following methods:
 - a. Conduits shall enter enclosures at the bottom wherever it is physically possible. Side entry is permissible. Top entry shall be avoided, and where unavoidable, top entry conduits shall be fitted with explosion-proof sealoff fittings, breathers, and drains.
 - b. Condensation buildup shall be prevented by heat from control transformers and other electrical components. If insufficient heat is available from component heat losses, anti-condensation heaters shall be provided.

2.7 PERFORMANCE REQUIREMENTS

- A. Heat Tracing Application: freeze protection.
- B. Minimum Ambient Design Temperature: -15 deg F.
- C. Process Piping Maintenance Temperature: See Heat trace Schedule on Contract Drawing E-031.
- D. Insulation type and thickness: As shown on the Drawings and specified.
- E. Pipeline will be subject to steam cleaning and shall be capable of withstanding intermittent exposure temperatures up to 450 deg. F.
- F. Heat tracing system shall have nominal wattage output as shown on the Drawings. Use the paragraph just below when watts per foot is not shown on the Drawings. Use the HT-___ tags for the heat trace power supply junction boxes that need to be shown on the Drawings.. Edit to suit Project.
- G. Spiral wrapping to achieve the specified heat output is acceptable.

- H. Cable shall be capable of providing at least 90 percent of nominal power output over a temperature range from 40 to 150 deg F (5 to 65 deg C) pipe temperature, and shall be capable of crossing over itself without overheating.
- I. The electrical heat tracing system shall maintain at least 75% of the specified wattage output in the specified environment for a minimum design life of 20 years when operated and maintained at less than the maximum continuous exposure temperature in accordance with the manufacturer's recommendations. The heat tracing system shall be certified to operate at 90% of power output after 1000 hours of exposure to the maximum intermittent exposure temperature when tested in accordance with UL 746B.

2.8 TEMPERATURE CONTROL AND MONITORING

- A. Freeze Protection Thermostat with Air Temperature Sensors: Provide line voltage thermostat with integral air temperature sensor and adjustable temperature range setpoint from 0 to 100 deg. F. Energize heat trace cabling when outside air temperature falls to 40 deg. F. Provide thermostat with green indicating lamp that is illuminated when thermostat is closed.
- B. Process Piping Temperature Control: Provide line voltage thermostat with remote bulb and capillary tube temperature sensor and adjustable temperature range setpoint from 0 to 100 deg. F. and adjustable dead-band from 5-20 deg. F. Energize heat trace cable when sensor temperature falls to 40 deg. F. and deenergize heat trace cable when temperature rises to 45 deg. F. Provide thermostat with green indicating lamp that is illuminated when thermostat is closed.
- C. Overtemperature Control For Plastic Piping: Provide line voltage thermostat with remote bulb with adjustable temperature range setpoint from 0 to 100 deg. F. De-energize heat trace cabling when pipe temperature reaches 80 deg. F (adjustable) or above. Provide thermostat with green indicating lamp that is illuminated when cables are energized.
- D. Low Temperature Alarm Thermostat: Provide thermostat with remote bulb and capillary tube temperature sensor and adjustable temperature range setpoint from 0 to 100 deg. F. Energize alarm when sensor temperature falls to 36 deg. F. Provide thermostat with red indicating lamp that is illuminated when thermostat is closed.
- E. Contactor-controlled branch circuit panelboard: Provide main circuit breaker, thermostatically-controlled contactor, and branch circuit breakers with 30 mA ground fault trip, as shown on the Drawings. Where required to accommodate the heat trace components furnished by a specified alternate manufacturer, the branch circuit breakers and branch circuit wiring shall be re-configured to suit the heat trace manufacturer's requirements at no additional cost to the Owner.
- F. Monitoring Panel: Measures pipeline temperature at locations shown on the Drawings, and provides local alarm and SPDT dry contact output(s) that closes on common alarm condition for remote monitoring.

2.9 HEAT TRACE ACCESSORIES

- A. Cable and Accessory Supports: Provide wrapping tapes, cable ties, and pipe clamps to fasten heat trace cables and accessories in place in accordance with manufacturer's installation instructions.
- B. Cold Junction Boxes: Threaded opening suitable for ¾ inch threaded conduit connection, cast aluminum with protective coating and gasketed screw cover. Provide green grounding screw for equipment ground wire, and spring clamp or screw terminals for line and neutral wires.
- C. Illuminated End Seals: Heat shrink insulation with "cable energized" LED type indicator lamp.
- D. Splices: Compression connectors, with heat shrink insulation over conductors and over outer jacket.
- E. Aluminum tape: Apply over heat trace cable for full length of plastic piping.
- F. Warning Labels: OSHA-approved colors and materials, with legend "Warning: Hazardous Voltage May Be Present From Electric Heat Tracing Under Pipe Insulation. Disconnect Heat Tracing Power Supplies Before Removing Pipe Insulation or Working On Heat Tracing."

2.10 FACTORY QUALITY ASSURANCE

- A. Factory Quality Certification
 - 1. Submit copy of factory quality assurance certificate.
- B. Manufacturing Process
 - 1. Heat tracing components shall be manufactured or outsourced in accordance with the factory quality certification documents.
- C. Factory Quality Assurance
 - 1. Cable production shall be monitored, controlled, and tested in accordance with the manufacturer's quality assurance program.
 - 2. Components shall be tagged and shipment shall be checked for completeness.

2.11 PACKAGING FOR SHIPMENT

- A. Package components in watertight pouches inside corrugated cardboard boxes with manufacturer and contents clearly labeled.

2.12 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions.
- B. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall

be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- C. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of electric heating cables that fail in materials or workmanship within specified warranty period.
- D. Warranty Period: Two years from date of Substantial Completion.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle heat tracing components in accordance with manufacturer's instructions and recommendations.

3.2 INSPECTION PRIOR TO INSTALLATION

- A. Piping and supports shall be substantially complete without burrs or sharp protrusions, tested, and clean prior to starting installation of heat tracing.
- B. Examine surfaces and substrates to receive heating cables for compliance with specified requirements for installation, including manufacturer's installation instructions and recommendations.

3.3 INSTALLATION

- A. In addition to following heat trace manufacturer's installation instructions and recommendations, perform the following work:
 - 1. Test cable buswires on reel for electrical continuity before installing.
 - 2. Test cable insulation resistance on reel before installing.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 4. Install heater-to-cold lead connections in accessible locations.
 - 5. Install end-of-line illuminated terminations in readily visible locations.
 - 6. Connect wiring in accordance with approved field wiring diagrams.
 - 7. Start acceptance tests.
 - 8. Apply pipe insulation.
 - 9. Finish acceptance tests

3.4 WIRING CONNECTIONS

- A. Connect heating cables and other components to power supply wiring as shown on the Drawings, or as shown on approved re-design drawings provided by a specified alternate heat trace manufacturer.
- B. Connect control wiring as shown on the manufacturer's approved field wiring diagrams.
- C. Grounding: Ground equipment according to Division "Electrical" Section "Grounding and Bonding for Electrical Systems".

- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.5 IDENTIFICATION IN THE FIELD

- A. Apply heat trace warning labels to heat traced piping, spaced at 10 foot intervals.
- B. Provide typed branch circuit panelboard schedule identifying each cold junction box.

3.6 ACCEPTANCE TESTING

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, cable, branch circuit, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. The heat trace manufacturer's factory-certified service technician shall supervise the beginning of installation for a minimum of one day, and shall certify successful completion of installation prior to initial energization.
 - 2. After heat trace system installation and prior to covering-up, the heat trace manufacturer's factory-certified service technician shall supervise testing prior to energization of the heat trace cables, adjust control settings, and certify that the installation has been completed and tested in conformance with the manufacturer's instructions and recommendations.
- C. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- D. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- E. Perform the following field tests and inspections and prepare test reports:
 - 1. Testing prior to initial energization, before application of pipe insulation:
 - a. Test cables for electrical continuity.
 - b. Test cables for insulation resistance. Replace cables if measured resistance is less than 10 megohms to ground.
 - c. Report results in writing.
 - 2. Testing prior to initial energization, before application of pipe insulation:
 - a. Test cables for electrical continuity.
 - b. Test cables for insulation resistance. Replace cables if measured resistance is less than 10 megohms to ground.
 - 3. Functional testing after energization:
 - a. Set thermostatic controls and monitor operation of heat tracing system under actual operating conditions if possible, otherwise test system with empty piping.

- b. Test cables to verify rating and power input. Energize branch circuit wiring. Record ambient temperature. Measure voltage and current simultaneously, and record test results at one minute intervals for 10 minutes.
- 4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.7 DEMONSTRATION AND TRAINING

- A. Review installation with Owner's Representative.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the heat tracing system.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete system of wiring and cabling, including wire and cable pulling, splicing, and termination accessories, as shown on the Drawings and in conformance with the requirements in this Section and Division 26 Section "Electrical - General".

1.2 RELATED DOCUMENTS

- A. Related requirements are also specified in the following Division 26 Sections:
 - 1. "Identification for Electrical Systems" for identification and color coding requirements.
 - 2. "Grounding and Bonding for Electrical Systems"
 - 3. "Medium-Voltage Cables" for single conductor and multi-conductor cables, cable splices, and terminations for electrical distribution systems over 600 V.

1.3 DEFINITIONS

- A. In addition to the definitions in Division 26 Section "Electrical - General", the following definitions apply to this Section:
 - 1. THHN: NEC and UL designation for flame-retardant and heat resistant thermoplastic insulation, gas and oil resistant nylon jacketed, suitable for dry locations only, 90 deg. C. max in dry locations
 - 2. THWN: NEC and UL designation for flame retardant and moisture-resistant thermoplastic insulation, gas and oil resistant nylon jacketed, suitable for dry and wet locations, 75 deg. C. max in wet locations
 - 3. TSP: twisted shielded pair
 - 4. XHHW: NEC and UL designation for (thermoset) cross-linked synthetic polymer insulation suitable for dry and wet locations, 90 deg. C. max in dry locations, 75 deg. C max in wet locations

1.4 REFERENCE STANDARDS

- A. Conform to the following standards in effect at the time of bid submittal:
 - 1. AEIC CG5-90 Underground Extruded Power Cable Pulling Guide
 - 2. ICEA P-51-432-1970 Copper Conductors, Bare & Weather Resistant
 - 3. ICEA S-58-679-1996 Standard for Control Cable Conductor Identification
 - 4. ICEA S-95-658 / NEMA WC70 Non-Shielded Power Cables Rated 2000 V or Less
 - 5. ICEA T-22-294-1983 Test Procedures for Extended Time-Testing of Wire and Cable Insulations for Service in Wet Locations
 - 6. ICEA T-33-655-1994 Low Smoke, Halogen-Free Polymeric Jackets

7. IEEE 576-2000 Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications
8. UL 44 Thermoset-insulated Wires and Cables
9. UL 62 Flexible Cord and Fixture Wire
10. UL 83 Thermoplastic Insulated Wires and Cable
11. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
12. UL 486C Splicing Wire Connectors
13. UL 486D Insulated Wire Connector Systems for Underground Use in Damp or Wet Locations
14. UL 493 Thermoplastic Insulated Underground Feeder and Branch Circuit Cables

1.5 SUBMITTALS

- A. Product Data: For each type of product specified herein, including catalog data, technical specifications, evidence of UL listing, and evidence of manufacturer's certification to ISO 9000:2000 or an equivalent quality management system certification acceptable to the Engineer.
- B. Qualifications and experience proposal for the electrical testing firm.
- C. Samples: Submit upon request.
- D. Electrical Acceptance Test reports.
- E. Operation and maintenance data is not required, however, approved shop drawing submittals are required to be included for the record in the Operation and Maintenance Manuals, as described in Division 26 Section "Electrical - General".

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain all wire and cable of a particular type through one source from a single qualified manufacturer.
- B. To be a qualified manufacturer, wire, cable, splice and termination components manufacturers shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer, and shall offer NRTL-listed and labeled products.
- C. Testing firm shall be qualified as defined by OSHA in 29 CFR 1910.7, shall be a member of the InterNational Electrical Testing Association, shall be acceptable to the AHJ, and shall have supervision as follows:
 1. Testing Firm's Field Supervisor: Qualifications and experience for the person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Wire and cable and accessories: Listed and labeled as defined in NEC Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 APPLICATIONS

- A. Refer to Part 3 for wire and cable applications.

2.2 MANUFACTURERS

- A. MANUFACTURERS

2.3 BUILDING WIRE AND MULTI-CONDUCTOR POWER CABLES

- A. Manufacturers:
 - 1. American Insulated Wire Corp.
 - 2. Belden Wire and Cable Co.
 - 3. Cerro Wire and Cable Co., Inc.
 - 4. General Cable Industries Inc.
 - 5. Okonite Co.
 - 6. Pirelli Cable Corp.
 - 7. Southwire Co.
 - 8. Or approved equal.
- B. Conductor Material: Copper, stranded conductor.
- C. Building Wire and Multi-conductor Cable Insulation Types: Type THHN-THWN, XHHW.

2.4 CONTROL AND INSTRUMENTATION WIRE AND CABLE

- A. Manufacturers:
 - 1. Belden Wire and Cable Co.
 - 2. Clifford of Vermont / TVC
 - 3. General Cable Co., Inc.
 - 4. Okonite Co.
 - 5. Lucent Technologies
 - 6. Siecor
 - 7. Southwire Co.
 - 8. Or approved equal.
- B. Control wire: 600V type THWN insulated stranded copper conductors in conduit, minimum size #14 AWG, UL listed and suitable for installation in conduit.
- C. Power-limited cable run concealed in building finishes: THWN in conduit.
- D. Power-limited tray cable, in cable tray: Multi-conductor type THHN/THWN, minimum size #14 AWG, with overall galvanized steel armor and PVC outer sheath. UL listed and suitable for installation in conduit and cable tray.
- E. Instrumentation cable, TSP for 4-20 mA DC circuits:

1. For installation in the same handholes, manholes, and pullboxes with power cables: 600 V TFFN insulated #16 AWG stranded tinned copper twisted pair, with #18 AWG or larger stranded tinned copper drain wire, overall aluminum-on-mylar shield (100% coverage), with chrome PVC outer jacket, maximum outside diameter 0.30 inches. NRTL listed and suitable for installation in conduit, cable tray, and direct burial.
 2. For installation in dedicated shielded signal cable raceways: 300 V TFFN insulated #16 AWG stranded tinned copper twisted pair, with #18 AWG or larger stranded tinned copper drain wire, overall aluminum-on-mylar shield (100% coverage), with chrome PVC outer jacket, maximum outside diameter 0.25 inches. NRTL listed and suitable for installation in conduit, cable tray, and direct burial.
- F. Instrumentation cable, twisted shielded triple for RTDs: 600 V TFFN insulated #16 AWG stranded tinned copper twisted triple, with #18 AWG or larger stranded tinned copper drain wire, overall aluminum-on-mylar shield, with chrome PVC outer jacket. NRTL listed and suitable for installation in conduit and cable tray.

2.5 VARIABLE FREQUENCY DRIVE (VFD) CABLING

- A. Manufacturers:
1. Belden series 29500
 2. Clifford variable frequency drive cable.
 3. Allied VFD shielded tray cable
 4. Or approved equal
- B. Description: Four conductor (1 ground), stranded tinned copper circuit conductors with PVC/XLPE insulation plus tinned copper braid shield (85 percent coverage) with tinned copper drain wire for powering motor powered by VFD's.
- C. Conductor: Stranded tinned copper; size as required.
- D. Insulation Voltage Rating: 1,000V, flexible motor supply cable.
- E. Insulation Type: Cross-linked polyethylene with PVC outer jacket.
- F. Shielding: Aluminum foil-polyester tape with tinned copper shield drain wire.

2.6 WIRE AND CABLE CONNECTORS AND SPLICES

- G. Manufacturers:
1. 3M Company, Electrical Products Division
 2. AMP Incorporated / Tyco International
 3. Burndy
 4. Square D
 5. Thomas and Betts
 6. Or approved equal.
- H. Description: Factory fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

- I. Wirenuts: Spring type rated for copper wire, sized for the actual number of wires connected.
- J. Splices: Tin-plated copper compression type. Pre-insulated crimp-on connectors may be used for #14 AWG control wires. Long barrel splices shall be used for #1/0 AWG and larger.
- K. Connection lugs: Tin-plated copper compression type with NEMA drilling. Long-barrel lugs shall be used for #1/0 AWG and larger wire, and for ground wires as specified in Division 26 Section "Grounding and Bonding for Electrical Systems".
- L. Connections at molded case circuit breakers, disconnect switches, and other equipment provided with wire termination lugs: NRTL-listed, suitable for use with the copper wire size to be connected.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Ensure that conduits, duct banks, manholes, handholes, and pullboxes are clean and clear of construction debris prior to installation of wire and cable.

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wire and cables to construction site and unload in accordance with manufacturer's recommendations.
- B. Store and transport reels in conformance with the manufacturer's printed instructions.
- C. Wire and cable ends shall be taped watertight until terminations and splices are completed.

3.3 WIRE AND CABLE APPLICATIONS

- A. Service Entrance: Type XHHW, single conductors in raceway.
- B. Feeders: Type XHHW, single conductors in raceway.
- C. Branch Circuits: Type THHN-THWN, single conductors in raceway.

3.4 CABLE LAYING AND PULLING

- A. Install cables in accordance with manufacturer's installation instructions, IEEE 576 and AEIC CG5-90.
- B. Run wires and cables in raceways as shown on the Drawings and as specified in Division 26 Section "Raceways and Boxes for Electrical Systems".
- C. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

- D. Pull wire and cables in accordance with the manufacturer's installation recommendations and requirements, with emphasis on the following:
 - 1. Do not exceed manufacturer's recommended maximum pulling tensions and side-wall pressure values
 - 2. Lubricate cables with pulling compound or lubricant that is approved by the cable manufacturer and will not deteriorate conductor or insulation materials of construction.
 - 3. Follow cable manufacturer's recommendations for attaching pulling means to cables, including fish tape, cable, rope, and basket-weave cable grips. Do not attach to cable jacket alone for pulling.
 - 4. Rig pulleys and use pull ropes for pulling cables into raceways.
 - 5. Use tension indicators and electric-motor driven capstan rollers for pulling cables that are too large for pulling by hand.
 - 6. Observe manufacturer's recommendations for the minimum wire and cable bending radius for each type and size of wire and cable provided for this project.
- E. Install "buried-cable" warning tape in the backfill above the cables as shown on the Drawings.
- F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around perimeter from entry to exit, and support cables at intervals adequate to prevent sagging.
- G. Seal around cables penetrating fire-rated elements according to Division "Thermal and Moisture Protection Section" Through-Penetration Firestop Systems."
- H. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems".

3.5 WIRE AND CABLE CONNECTIONS AND TERMINATIONS

- A. Tighten electrical connectors and terminals according to the manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. For compression lugs and splices, use the lug manufacturer's compression tools and conform to the manufacturer's written instructions.
- C. Control wires shall be run from terminal to terminal without splices, and no more than two wires under a terminal screw.
- D. Splices and terminations shall be insulated with boots, heat shrink tubing, or tape to 600 volts in accordance with the insulation product manufacturer's written instructions.
- E. Feeder taps shall be made with cast bronze 2-bolt or 4-bolt connectors with built-in conductor spacer, suitable for the run and tap conductor sizes. Split bolt connectors shall not be used unless approved by the Engineer.
- F. Wiring at Device Outlets: Install conductor at each outlet, leaving 8 inches (200 mm) of wire coiled in the box for connection to wiring devices. Wiring devices that are suitable for solid wire only shall be pigtailed to stranded wire with solid wire 6 inches long using wirenuts.

- G. Install a green insulated NEC-sized grounding jumper from a green ground screw in the outlet box to the receptacle or switch green ground screw.
- H. Wiring to terminals at transformers and busbars shall be connected with tin-plated copper compression connectors and insulated for 600 volts with tape, boots, or heat-shrink tubing rated for the temperature specified by the equipment manufacturer. Two hole lugs shall be used for power cable terminations # 1/0 AWG and larger.
- I. Building wire connections to flexible motor leads shall be made with compression connectors bolted back-to-back with silicone-bronze bolts and insulated for 600 volts. For motors with busbar connections, connections shall be made with long-barrel two-hole tin plated copper lugs, copper-plated belleville washers, and silicone bronze bolts.
- J. Shielded cable conductors shall be terminated with insulated crimp-on connectors suitable for the terminals provided with the equipment, or tinned for connection to terminals which are not suitable for crimp-on connectors. A minimum two inch length of heat shrink tubing shall be applied over each insulated conductor and the insulated portion of the crimp-on connector, and a separate piece of larger diameter heat shrink tubing shall cover the end of the cable jacket and cut shield, and overlap the individual conductor heat shrink tubing. Connect drain wire to the ground bus at the transmitter end only except where otherwise indicated on the Contract Drawings and approved shop drawings.

3.6 ELECTRICAL ACCEPTANCE TESTING

- A. Testing: Engage a qualified testing agency to perform the following field quality control testing:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for conformance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification, Section 7.3.2 "Cables, Low Voltage, 600 Volt Maximum". Certify conformance with test parameters.
- B. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that conform to requirements
 - 3. Test results that do not conform to requirements and corrective action taken to achieve conformance with requirements.

END OF SECTION

SECTION 26 05 20

DATA HIGHWAY CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

- A. Provide copper and fiber optic cables and accessories for Process Control and communications as shown on the Drawings and specified herein.
- B. Only new equipment and material, produced by manufacturers that are recognized nationally by the telecommunications industry and approved by Underwriters Laboratory shall be used.

1.3 RELATED WORK

- A. Division 26 Section "Raceways, Boxes, and Fittings" for conduits.

1.4 CODES AND STANDARDS

- A. Material and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. Underwriters Laboratories (UL): Applicable listings and ratings
 - 2. Underwriters Laboratory (UL) LAN Cable Certification Level 5
 - 3. National Electric Code (Articles 770, 800, latest issue), and local state Electrical Codes
 - 4. National, State, and Local OSHA, building and fire codes
 - 5. ANSI X3T9.5 / Requirements for UTP at 100 Mbps.
 - 6. ANSI/EIA/TIA-568A, 569, 606, and 607, TSB-75, and TSB-67, Standard: Commercial Building Telecommunications Wiring (1995 or latest)
 - 7. ANSI/TIA/EIA - 492AAAA - Detail Specification for 62.5 mm Core Diameter/125 mm Cladding Diameter Class 1a Graded Index Multimode Optical Fibers.
 - 8. ANSI/TIA/EIA - 492BAAA - Detail Specification for Class IVa Dispersion Unshifted Single-Mode Optical Fiber.
 - 9. IEEE (Institute of Electrical and Electronic Engineers) 802.3 Ethernet.
 - 10. BICSI Telecommunications Distribution Methods Manual (1995 or latest)
 - 11. FCC Part 68.500
 - 12. TIA/EIA - 568A - Commercial Building Telecommunications Cabling Standard.

- B. Conformance
 - 1. Work and materials shall conform to the latest rules of the National Electric Code, the National Board of Fire Underwriters (wherever standards have been established), the National Fire Protection Association (NFPA 70-1990 or latest) and conform to the regulations of the State Fire Marshall, all OSHA regulations and requirements, and the local building, fire and electrical codes of the various locations nationwide. Nothing in these specifications shall be construed to permit work not conforming to the most stringent of applicable codes.
- C. Should any change be necessary to the Communications Drawings or specifications to make the work comply with these requirements, the Electrical Contractor shall notify the Owner at once and temporarily cease work on all parts of the contract, which are affected.

1.5 SUBMITTALS

- A. Submittals shall be in accordance with the Supplementary Conditions and Division 1.
- B. Product Data: For each type of product specified herein, including catalog data, technical specifications, evidence of UL listing, and evidence of manufacturer's certification to ISO 9000:2000 or an equivalent quality management system certification acceptable to the Engineer
- C. Samples: Submit 16-inch (400-mm) lengths of each size and type of cable upon request.
- D. Cable test reports
- E. Fiber testing results and OTDR graphs noted with the manufacturer's maximum loss recommendations.

PART 2 - PRODUCTS

2.1 HARDWARE

- A. Fiber Optic Cables
 - 1. Shall be Indoor/Outdoor, 62.5/125 μ m multimode fiber, loose or single tube construction, riser rated cable with interlocking steel or aluminum armor.
 - 2. Fiber counts shall be 12 fibers per cable.
 - 3. Acceptable manufacturers are:
 - a. Siecor (Corning) Model: Freedom Indoor/Outdoor, Gel-Free, Interlocking Armored Cable
 - b. Belden
 - c. Brand-Rex Co.; Unit of BICC Cables Corp.
 - d. Or equal
 - 4. Patchcords
 - a. Pre-terminated patchcords of length and terminations as required.
 - 5. Terminal and Connector Components and Distribution Racks:
 - a. Siecor (Corning) - Unicam multimode connectors
 - b. Siecor (Corning) - WIH wall-mount interconnect housing (WIH)

- c. AMP Incorporated; a Tyco International Ltd. Company.
 - d. Hubbell Premise Wiring.
 - e. Leviton Telecom.
 - f. Lucent Technologies; Global Service Provider.
 - g. Panduit Corp.
 - h. Thomas & Betts Corporation.
 - i. Or approved equal
 - 6. Innerduct (Indoor Cable Tray or Exterior Ductbank installations)
 - a. Interior – Cable Tray Use: Carlon or equal General Purpose Duct, Size as required.
- B. Ethernet Cable
- 1. Four pair, polyolefin insulated #23 AWG solid copper conductors, unshielded with overall PVC jacket.
 - 2. Jacket Color shall be orange for Control Network connections and blue for administrative network connections.
 - 3. Belden catalog no. 11872A or equal.
- C. Coaxial Cable
- 1. Shall be 6-series quad shield—18 AWG solid 0.040” bare copper conductor, gas-injected foam high density polyethylene insulation, copper braid shield and PVC outer jacket material.
 - 2. Cables shall be rated for temperature of -30° C to 75 °C, 75Ω, 53pF/m, 300V RMS max operating voltage.
 - 3. Provide terminals and taps as required.
 - 4. Provide lengths as required.
 - 5. UL labeled and tested.
 - 6. Allen Bradley 1786-RG6 or equal

PART 3 - EXECUTION

3.1 GENERAL

- A. Patch panels shall be required at each fiber optic termination and may be either within the destination enclosure or, with approval, be separately wall mounted. All fibers, including spares are to be terminated.
- B. Pre-terminated patchcords shall be used to make connections from fiber patch panels to equipment.
- C. In no event shall any cables be spliced.
- D. Grounding:
 - 1. Installer shall individually and properly ground all racks, cable trays, equipment cabinets, and inside and outside plant cable shields, wherever the cables leave the sheaths, to ground bars.
 - 2. Installer shall individually and properly ground all voice punch-down cable

- frames and other Electrical Contractor-supplied hardware to the ground bars.
- 3. Daisy chaining of equipment grounding is not permitted.
- 4. Grounding shall conform to EIA/TIA 607 and NEC articles 250 and 800. NEC Article 800-40 requires minimum #6 AWG, or better, wire be used for grounding to main building ground.
- E. When installing cables in conduits with pull-strings, replace pull-strings used with new ones.
- F. Perform a daily cleanup following all installations and terminations.

3.2 INSTALLATION

- A. All installation work shall be done by qualified craftspeople in a neat, high quality manner and shall conform with the most stringent of applicable local, state and federal building codes pursuant to Section 1 of this Specification.
- B. The installation Contractor shall be trained and certified by the cable manufacture in the installation procedure set forth by that manufacture.
- C. Cables shall be placed with sufficient bending radius so as not to kink, shear, or damage jackets, binders or cables, including where cables are coiled for future use or slack. Bending shall not exceed manufacturers specified bend radii. Cable shall not be wrapped around the feet of systems furniture.
- D. Tie wraps shall not be pulled so tight as to kink or crimp the cable jackets.
- E. Labeling Scheme
 - 1. Station cables are to be machine labeled on each end of the cables, both at the workstation outlets, and on the patch panels within 2 inches of the termination, on the face of the workstation outlets, on the 110 blocks, and on the face of the patch panels.
 - 2. Final outlet and block labeling methods to be approved by Owner before labeling is done on outlets and blocks.

3.3 TESTING

- A. Copper Cable testing:
 - 1. Testing of all copper wiring shall be performed prior to and as a condition of Owner acceptance. 100 percent of the horizontal wiring pairs shall be tested as follows. The Category 5 or 6 cable runs shall be tested for conformance to the specifications of EIA/TIA 568A Category 5E.
 - 2. All horizontal cables, outlets and terminations must meet or exceed all performance specifications designated by ANSI, EIA/TIA 568A Annex E, or IEEE, for telephone, terminal to CPU, 10 Base T, 100 Base T, 1000 Base T, and FDDI.
 - 3. Testing of all data horizontal cables and outlet jacks, must include end-to-end tests using an EIA / TIA TSB 67, Level II compliant testing device such as a Microtest OMNI Scanner or Owner approved equal. The documentation must

show the outlet designation, the name of the technician who actually performs the test, as well as the time and date when the test was performed. The results for each data workstation outlet must show the results of the following tests:

- a. Shield Continuity (if connected)
- b. Opens
- c. Grounds/Shorts
- d. Crossed Pairs
- e. Split Pairs
- f. Reversed Pairs
- g. NEXT @ from 1.0 to 300 MHz 6 pr combinations
- h. Return Loss @ from 1.0 to 300 MHz
- i. Attenuation @ from 1.0 to 300 MHz
- j. ELFEXT @ from 1.0 to 300 MHz 24 pr combinations
- k. ACR all 4 pairs
- l. Length 0 to 457m
- m. Resistance 0 – 500w
- n. Power Sum
- o. NEXT
- p. ACR
- q. ELFEXT

4. Any cables failing to meet above indicated standards must be removed and replaced, at no cost to the Owner, with cables that prove, in testing, to meet the standards. The installation will not be accepted until testing documentation has reported that all pairs in all cables meet the appropriate standards.

B. Fiber-Optic cable testing:

1. Perform each visual and mechanical inspection and electrical test, including optional procedures, stated in NETA ATS, Section 7.25.
2. All fibers including spares shall be terminated and tested for end-to-end attenuation losses at 850 and 1300nm.
3. Tests should be conducted in compliance with EIA/TIA-526-14, Method B, according to the manufacturer's instructions for the test set being utilized.
4. Test results shall be provided in a 3-ring binder for each fiber segment, including spares.
5. Broken Fibers and Fiber segments with losses higher than manufactures specifications for fiber connector assemblies shall be repaired or replaced.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete system of grounding electrodes, grounding electrode conductors, main bonding jumpers, equipment grounding conductors, and bonding in accordance with NEC requirements, in conformance with this Section and as shown on the Drawings.
- B. This Section includes requirements for grounding electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.2 RELATED DOCUMENTS

- A. Related Documents include the following Division 26 Sections:
 - 1. "Underground Ducts and Raceways for Electrical Systems" for additional grounding and bonding requirements
 - 2. "Low-Voltage Electrical Power Conductors and Cable" for wire connector and equipment grounding conductor requirements
 - 3. "Raceway and Boxes for Electrical Systems" for grounding bushing requirements

1.3 DEFINITIONS

- A. Refer to NEC for definitions of grounding terms used in this Section.

1.4 QUALIFICATIONS

- A. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer. The manufacturing company shall be listed in a published NRTL directory of companies offering NRTL-listed and labeled products.
- B. Testing Firm Qualifications: An independent firm, with experience and capability to conduct specified tests, and is a member company of NETA or is an NRTL as defined by OSHA in 19 CFR 1910.7, acceptable to the AHJ.
- C. Testing Firm's Field Supervisor Qualifications: person currently certified by NETA or NICET to supervise on-site testing specified in Part 3.

1.5 REFERENCE STANDARDS

- A. Comply with the following standards:
 - 1. IEEE 81-1983 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

2. IEEE 118-1978 (R1992) Standard Test Code for Resistance Measurements
3. IEEE 142-1991 Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)
4. IEEE 1100-1999 IEEE Recommended Practice for Powering and Grounding Electronic Equipment. (IEEE Emerald Book)
5. IEEE C57.13.3-1983 (R1990) Guide for the Grounding of Instrument Transformer Secondary Circuits and Cases
6. IEEE C57.13.3-1983 (R1991) Guide for the Grounding of Instrument Transformer Secondary Circuits and Cases
7. NFPA 70 The National Electrical Code

1.6 SUBMITTALS

- A. Conform to the General Conditions.
- B. Product Data: Submit manufacturer's catalog data and specification sheets for each manufacturer's product described in Part 2 of this Section, marked to show which products are proposed for this project.
- C. Qualification Data: For firms and persons specified in "Qualifications" in Part 1 of this Section.
- D. Acceptance Test Reports: Submit written test reports to include the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with the requirements described in this Section, provide products by one of the listed manufacturers in the Sub-Sections below.
 1. Ground Rods:
 - a. Copperweld Corp.
 - b. Eritech / Erico International Corporation
 - c. Galvan Industries, Inc.
 - d. Harger Lightning and Grounding, Inc.
 - e. Robbins Lightning, Inc.
 2. Grounding electrode connectors:
 - a. Exothermic type:
 - 1) Cadweld / Erico International Corporation
 - 2) Furseweld
 - 3) Harger Lightning and Grounding, Inc. (Ultraweld)
 - 4) ThermOweld, a division of Continental Industries
 - b. Copper compression type:
 - 1) Dossert Corp.
 - 2) Framatome Connectors / Burndy

- 3) Harger Lightning and Grounding, Inc.
- 4) ILSCO
- 5) O. Z. Gedney / EGS Electrical Group
- 6) Panduit Corp.
- 7) Robbins Lightning, Inc.

2.2 GROUNDING ELECTRODES

- A. Ground Rods: 3/4 in. x 10 ft. copper-clad steel, sectional type, with silicone bronze threaded connectors.
- B. Ground Ring: #4/0 AWG Class A stranded copper conductor (7 strand). 17 strand ground wire is not acceptable in contact with earth.
- C. Concrete-Encased Electrodes: Fabricate from a minimum of 20 feet (6 m) of non-structural reinforcing steel at least 1/2 inch diameter, bent 90 degrees at corners to fit inside the building footing concrete formwork.

2.3 GROUNDING ELECTRODE CONDUCTORS

- A. Grounding Electrode Conductors: #4/0 AWG, Class A stranded tinned bare copper conductor. Class B stranding is not acceptable for conductors in contact with earth.
- B. Comply with the following:
 1. Solid Conductors: ASTM B 3.
 2. Assembly of Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.

2.4 BONDING JUMPERS

- A. Main Bonding Jumpers: copper, furnished with the service equipment by the equipment manufacturer. Panelboards up to 225 amps may use a bonding screw.
- B. Equipment Bonding Jumpers: insulated copper building wire, sized to match the largest equipment grounding conductor in the associated conduits.
- C. Bonding Jumper: insulated copper wire, protected by conduit where exposed to physical damage
- D. Electrical and telephone room ground bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.5 EQUIPMENT GROUNDING CONDUCTORS

- A. Equipment Grounding Conductors: Insulated building wire in accordance with Division 26 Section "Low-Voltage Electrical Power Conductors and Cable". #6 AWG and smaller shall have green insulation, #4 AWG and larger shall have green insulation or shall be marked with green tape at each end.

2.6 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467. Products shall be NRTL-listed and shall be suitable for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: two-hole long barrel tin-plated copper compression type at equipment busbars and bonding connections to structural steel.
- C. Grounding clamps for metal water pipe connections: all cast bronze parts with silicone bronze bolts.
- D. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- E. Wirenuts: Use only for branch circuit wiring in switch and receptacle outlet and junction boxes containing #10 AWG and smaller wires.

PART 3 - EXECUTION

3.1 INSTALLATION – GENERAL

- A. Install grounding electrodes, grounding electrode conductors, main bonding jumpers, equipment grounding conductors, equipment bonding jumpers, and bonding, in accordance with NEC requirements and as shown on the Drawings.
- B. Provide only copper and bronze grounding materials in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- C. Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- D. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

3.2 INSTALLATION: GROUNDING ELECTRODES

- A. Concrete-Encased Grounding Electrode: Connect one grounding electrode conductor to the non-structural reinforcing steel at each footing using exothermic welding method, and extend to building service equipment ground bus. For steel framed buildings, connect one grounding electrode conductor to the 3/4 inch minimum non-structural reinforcing steel at each footing using exothermic welding method, extend to closest building steel corner

column., and fasten to web of column 12 inches above floor using exothermic weld. Additional grounding electrodes shall be provided where indicated on the Drawings.

- B. Ground Rods: Install ground rods in triangular configuration least two rod lengths apart at the four outside corners of the building, as shown on the Drawings.
 - 1. Drive ground rods until tops are 30 inches below finished floor or final grade, unless otherwise indicated.
 - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds. Make connections without exposing steel or damaging copper coating.
- C. Metal Water Service Pipe: Provide insulated copper grounding electrode conductor, in conduit, from the building main service equipment ground bus to the closest main metal water service entrance to the building as shown on the Drawings. Connect grounding electrode conductor to main metal water service pipes with grounding clamp. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting.
- D. Remove paint and surface corrosion from structural steel and metal water pipes at grounding connection points down to bright metal, and coat dissimilar metals with anti-corrosion compound after making grounding connections wrench-tight.
- E. Water Meter Piping: Use braided-type bonding jumpers, with cross sectional area at least equal to the NEC-required grounding electrode conductor size, to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- F. Ground ring: Use tinned bare Class A stranded (7-strand) copper conductor, #4/0 AWG . Bury at least 30 inches below grade

3.3 INSTALLATION: GROUNDING ELECTRODE CONDUCTORS

- A. Grounding Electrode Conductors: Route along shortest and straightest paths possible, unless otherwise indicated on the Drawings. Avoid obstructing access or placing conductors where subject to strain, impact, or damage.
- B. Connect grounding electrode conductor(s) to the service entrance equipment ground bus.
- C. For connections to structural steel and for underground connections, provide exothermic-welded connections.
- D. Bond grounding electrode conductors in metal conduits to each end of each conduit run using a bronze conduit-to-wire grounding fitting.

3.4 INSTALLATION: EQUIPMENT GROUNDING CONDUCTORS

- A. Provide separate insulated equipment grounding conductors in raceways, boxes, and fittings, as shown on the Drawings and specified herein.
- B. Equipment Grounding Conductor Terminations:

1. At dry-type transformers, provide two-hole long-barrel tin-plated compression connector bolted to ground busbars with tin-plated or silicone bronze bolts.
2. At switchgear, switchboards, distribution boards, panelboards, and motor control centers, provide two-hole long-barrel tin-plated compression connector bolted to ground busbar(s) with tin-plated or silicone bronze bolts.
3. At generators, provide separate two-hole long-barrel tin-plated compression connector bolted to ground connection point in generator terminal box, and to generator structural steel frame, with tin-plated or silicone bronze bolts.

3.5 INSTALLATION: EQUIPMENT BONDING JUMPERS

- A. At sheet metal junction, pull and outlet boxes, and electrical enclosures, use conduit hubs bolted to enclosure or double locknuts to bond enclosure to conduit, and connect grounding bushings to equipment grounding conductors. Install equipment bonding jumpers between conduit bushings entering and leaving boxes, using the lugs provided with the grounding bushings.
- B. At cast enclosures, connect equipment grounding conductors together with a mechanical connector. Use mechanical connectors in conformance with Division 26 Section "Low-Voltage Electrical Power Conductors and Cable".
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Signal and Communication Systems: For telecommunications systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4 x 2 x 2 inch ground bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. Metal Poles Supporting Outdoor Lighting Fixtures: Provide grounding as detailed on the Drawings.
- F. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.6 INSTALLATION: MAIN BONDING JUMPERS

- A. Install main bonding jumpers at service entrance equipment in accordance with service equipment manufacturer's written instructions.

3.7 INSTALLATION: BONDING JUMPERS

- A. Bonding Straps and Jumpers: Install so equipment vibration is not transmitted to rigidly mounted equipment support structure. Use long-barrel tin-plated compression connectors and galvanized steel or silicone bronze hex head cap screws in drilled and tapped holes to bond miscellaneous equipment to equipment grounding conductors.
- B. Bond interior structural steel, and all metal piping systems entering or exiting a building to the ground ring in conformance with NEC Article 250.104 and as shown on the Drawings.
- C. Ground Bus: Install in electrical and telecommunications equipment rooms as shown on the Drawings.
 - 1. Use insulated spacer; 1 inch space from wall and support from wall 6 inches above finished floor, unless otherwise indicated.

3.8 CONNECTIONS

- A. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- B. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

3.9 OVERHEAD-LINE GROUNDING

- A. Comply with IEEE C2 requirements. Add a section to driven ground rod if single ground rod electrode resistance to ground exceeds 25 ohms.
- B. Drive ground rods to a depth of 12 inches below finished grade in undisturbed earth.
- C. Ground Rod Connections: Use clamp-type connectors listed for the purpose for underground connections and connections to rods.
- D. Lightning Arresters: Separate arrester grounds from other grounding conductors.
- E. Secondary Neutral and Tank of Transformer: Interconnect and connect to grounding conductor.
- F. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

3.10 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Manholes: Install a driven ground rod close to wall so 4 inches will extend above finished floor. If installing manholes in rocky soil, install ground rod before manhole is placed and provide a #4/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrink insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening watertight with non-shrink grout.
- B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with #6 AWG minimum, solid, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Pad-Mounted Transformers and Switches: Install minimum two ground rods and ground ring encircling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting to ground ring. Use tinned-copper conductor not less than #4/0 AWG for connections to equipment ground pad. Bury ground ring not less than 18 inches below grade and 6 inches from the foundation.

3.11 ACCEPTANCE TESTING

- A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
 - 1. After installing grounding system and before electrical circuitry has been energized, test for conformance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification, Section 7.13 "Grounding Systems". Certify conformance with test parameters.
- B. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that conform to requirements.
 - 3. Test results that do not conform to requirements and corrective action taken to achieve conformance with requirements.
- C. Ground resistance shall be 5 ohms or less.

3.12 GRADING AND PLANTING

- A. Restore surface features, including vegetation and paving, at areas disturbed by Work of this Section. Comply with Division "Existing Conditions" Section "Restoration of Surfaces".

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete system of raceways, including conduit, fittings, terminal boxes, hangers, supports, and accessories, as shown on the Drawings and specified herein.

1.2 RELATED DOCUMENTS

- A. Related requirements are also included in the following Division 26 Sections:
 - 1. "Underground Ducts and Raceways for Electrical Systems" for duct bank construction requirements.
 - 2. "Grounding and Bonding for Electrical Systems" for equipment grounding requirements.

1.3 DEFINITIONS

- A. In addition to the definitions in Division 26 Section "Electrical - General", the following definitions apply to this Section:
 - 1. Clamp-back: spacer used with conduit one-hole strap to provide air gap between surface and conduit
 - 2. EPDM: Ethylene-propylenediene terpolymer rubber
 - 3. Equipment bonding jumper: suitable for connecting sections of conduit used for equipment grounding conductor (see NEC definition)
 - 4. FMC: Flexible metal conduit (NEC definition)
 - 5. FRP: fiberglass reinforced plastic
 - 6. ID: inside diameter
 - 7. LFMC: Liquidtight flexible metal conduit (NEC definition)
 - 8. LFNC: Liquidtight flexible nonmetallic conduit
 - 9. NBR: Acrylonitrile-butadiene rubber
 - 10. NPT: National pipe thread
 - 11. OD: outside diameter
 - 12. PVC: Polyvinyl chloride
 - 13. PVC Coated-RGS: Polyvinyl chloride Rigid galvanized steel conduit
 - 14. RAC: Rigid aluminum conduit
 - 15. RGS: Rigid galvanized steel conduit
 - 16. RMC: Rigid metal conduit (NEC definition)
 - 17. RNC: Rigid nonmetallic conduit (NEC definition) includes PVC and RTRC
 - 18. RTRC: Reinforced thermosetting resin conduit (fiberglass conduit - NEC definition)

1.4 REFERENCE STANDARDS

- A. Comply with the following standards:
 - 1. NEMA Standards applicable to raceways, boxes, and fittings.

2. UL Standards applicable to raceways, boxes, and fittings. Each raceway, box, and fitting shall be NRTL-listed and labeled.
3. ANSI and ASTM standards mentioned in this Section and included in the UL and NEMA Standards applicable to raceways, boxes, and fittings.

1.5 ENVIRONMENTAL CONDITIONS

- A. Provide raceways, boxes, and fittings fabricated from materials resistant to corrosion and suitable for the application in the locations where installed, in conformance with NEC requirements for installation in “damp”, “wet”, and hazardous (classified) areas.

1.6 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 1. Custom enclosures and cabinets.
 2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 1. Structural members in the paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
 3. Coordinate layout and installation of raceways, boxes, fittings, hangers, enclosures, cabinets, and supports with other construction, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70 and NEMA standards.
- C. PVC-coated conduit, boxes, and fittings that are connected together shall be from the same manufacturer.

PART 2 - PRODUCTS

2.1 CONDUIT, BOX, AND FITTING MANUFACTURERS

- A. Provide products by the following manufacturers:
1. Adalet / A Scott Fetzer Company
 2. AFC Cable Systems, Inc.
 3. Alflec Inc.
 4. Allied Tube & Conduit Corporation
 5. Allied Tube and Conduit Div. / A TYCO International Ltd. Company
 6. Anamet Electrical, Inc.; Anaconda Metal Hose.
 7. Appleton
 8. Bell
 9. Carlon
 10. Cooper / B-Line
 11. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 12. Electri-Flex Co.
 13. Emerson/General Signal; Appleton Electric Company.
 14. Erickson Electrical Equipment Co.
 15. Hoffman.
 16. Hubbell, Inc. / RACO
 17. Hubbell, Inc./ Killark Electric Manufacturing Co.
 18. Lew Electric Fittings Co.
 19. LTV Steel Tubular Products Company
 20. Myers
 21. O-Z Gedney
 22. Perma-Cote
 23. Pittsburgh Standard Conduit Co.,
 24. RACO; Division of Hubbell, Inc.
 25. Robroy Industries
 26. Robroy Industries, Inc.; Enclosure Division.
 27. Scott Fetzer Co.; Adalet-PLM Division.
 28. Spring City Electrical Manufacturing Co.
 29. Thomas & Betts Corporation.
 30. Triangle PWC Co.
 31. Wheatland Tube Co.
 32. Or approved equal.

2.2 PVC-COATED RIGID METAL CONDUIT

- A. Rigid Galvanized Steel Conduit (RGS): hot dip galvanized exterior and interior to ANSI C80.1, threads hot dip galvanized after fabrication, for use in accordance with NEC Article "Rigid Metal Conduit: Type RMC", NRTL-listed and labeled under UL 6. Threads shall be hot dip galvanized after fabrication.
- B. PVC-Coated RGS: RGS with .040 inch PVC exterior coating, and .002 urethane or epoxy interior coating. Threads shall be protected with urethane coating over galvanizing.
- C. Provide RMC locknuts, bushings, fittings, conduit bodies, junction boxes, pull boxes, and outlet boxes as follows:

1. NEMA ratings: in accordance with Part 3 of this Section
2. Locknuts: stainless steel. Locknuts on outside of NEMA 12 sheet metal enclosures shall be sealing O-ring type.
3. Bushings: stainless steel, insulated-throat grounding type, with thermoset plastic insulation insert, complete with mechanical ground lug for connection to ground wire.
4. Fittings: ANSI 80.4, stainless steel. Conduit hubs or similar approved fittings shall be provided for conduit entry to water and dust-resistant enclosures.
5. Conduit bodies: galvanized cast steel or malleable iron Form 8 with oil-resistant gasket and galvanized cast steel or malleable iron cover.
6. Junction boxes: stainless steel with oil-resistant gasket, and cast or malleable iron external screw cover type in hazardous (classified) areas.
7. Pull boxes: stainless steel fabricated sheet metal type with hinged screw cover in non-hazardous areas, cast aluminum with hinged bolted cover in hazardous (classified) areas.
8. Outlet boxes: Type FS or FD for exposed locations in non-hazardous areas, cast or malleable iron external screw cover type in hazardous (classified) areas.
9. PVC-coated fittings, conduit bodies, junction boxes, pull boxes, and outlet boxes: Same as RGS described above, with exterior and interior coatings similar and equal to PVC-coated RGS conduits, and shall have PVC sleeves extending approximately one conduit diameter beyond threaded hub for conduit overlap. Provide stainless steel cover screws.
10. Explosion-proof flexible couplings: UL listed and labeled for the hazardous (classified) area location, with stainless steel outer braid. Non-stainless steel parts shall be PVC-coated when used with PVC-coated RGS conduit.
11. Explosion-proof sealoffs: : UL listed and labeled for hazardous (classified) area location, cast metal, combination horizontal and vertical type, oversized for 40% wire fill to match allowable wire fill in conduit, with breather and drain. Non-stainless steel parts shall be PVC-coated when used with PVC-coated RGS conduit.
12. Terminal boxes: Enclosures for terminal blocks and electrical equipment and components: NEMA 250, with interior white painted steel panel, and hinged cover. Stainless steel sheet metal with flush 1/4-turn latch for non-hazardous areas, cast aluminum with hinged and bolted cast cover for hazardous (classified) locations.

2.3 RIGID NON-METALLIC CONDUIT

- A. Rigid non-metallic conduit: Schedule 80 polyvinyl chloride conduit to NEMA TC-2, for use in accordance with NEC Article "Rigid Nonmetallic Conduit: Type RNC", NRTL-listed and labeled under UL 651.
- B. RNC Fittings: solvent-welded PVC, NRTL listed and labeled, by same manufacturer as the conduit.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Liquidtight flexible metal conduit (LFMC): Flexible steel type UA conduit with PVC jacket, for use in accordance with NEC Article "Liquidtight Flexible Metal Conduit: Type LFMC", NRTL-listed and labeled under UL 360. Non-UL listed LFMC is not acceptable.

- B. Fittings: Insulated-throat screw-in connectors, NEMA FB 1, UL 514B, galvanized malleable iron or steel. Connectors shall be suitable for use as grounding fittings. Provide fittings with bonding jumper connections for exterior bonding jumpers at motors. Non-stainless steel parts shall be PVC-coated when used with PVC-coated RGS conduit.

2.5 SINGLE CONDUIT HANGERS

- A. Manufacturers:
1. Appleton
 2. Crouse-Hinds
 3. Erico International Corporation (Cm addy)
 4. Killark
 5. Thomas and Betts (Kindorf, Steel City)
 6. Unistrut
 7. Or approved equal
- B. Single PVC-coated RGS attachment to structural steel: PVC coated steel PC (parallel clamp), EC (edge clamp), and RC (right angle clamp) type conduit-to-structural-steel clamps, or PVC-coated steel clevis hangers on stainless steel threaded rods attached to stainless steel beam clamps. Bolts shall be stainless steel.
- C. Single PVC-coated RGS attachment to concrete and masonry surfaces: PVC-coated steel one-hole clamp and PVC-coated steel clamp-back, or PVC-coated steel clevis hangers on stainless steel threaded rods attached to stainless steel rod hanger fitting bolted to concrete with expansion bolts. Bolts shall be stainless steel.
- D. PVC-coated rigid galvanized steel conduit hangers shall be same as specified for RGS except with PVC coating, and 316 stainless steel bolts.

2.6 MULTIPLE CONDUIT HANGERS (CHANNEL SUPPORTS)

- A. Manufacturers:
1. Aickinstrut
 2. Cooper B-Line
 3. GS Metals Inc.
 4. Thomas & Betts (Kindorf)
 5. Unistrut
 6. Or approved equal
- B. Steel channel and associated hardware and fittings:
1. 1-1/2 x 1-1/2 inch nominal size, minimum. UL 5B listed and labeled. Thickness as required for the application, minimum 0.071 inches.
 2. Deflection of individual support channels shall not exceed 1/180 of span when loaded with conduit plus 200 pounds.
 3. Stainless steel: Type 304 or better
 4. Bolts: Grade 3 or better. Finish and materials to match channel.
 5. Conduit straps: PVC-coated galvanized steel with stainless steel bolt.
- C. Fiberglass channel and associated hardware and fittings:

1. 1-1/2 x 1-1/2 inch nominal size, minimum. UL 94VO listed and labeled. Thickness as required for the application, minimum 1/8 inch.
2. Deflection of individual support channels shall not exceed 1/180 of span when loaded with conduit plus 200 pounds.
3. Materials of construction: fiberglass reinforced vinyl ester or polyester, resistant to chemicals in use in the area.
4. Bolts, fittings, and conduit straps: Corrosion-resistant materials, as recommended by the fiberglass reinforced channel manufacturer for the application and loading.

2.7 CONDUIT SLEEVES AND SEALING FITTINGS

A. Manufacturers:

1. Appleton
2. Crouse-Hinds
3. Spring City Electric
4. Thomas & Betts
5. O.Z. Gedney
6. Or approved equal

B. Wall and Floor Sleeves:

1. Stainless steel pre-fabricated conduit sleeves with welded water-stop ring.
2. Galvanized steel, PVC, and polyethylene sleeves that are part of a manufacturer's standard wall seal assembly are also acceptable, subject to compliance with the fire resistant rating of the related walls and floors.

C. Conduit-to-Sleeve Sealing Fittings:

1. Synthetic elastomeric gland with stainless steel compression plates sized for the conduit OD and sleeve ID, or a manufactured assembly of stainless steel pressure plates, neoprene sealing grommets, and cast or malleable iron sealing bodies with zinc-rich epoxy coating, with factory-assembled galvanized steel, PVC, or polyethylene pipe sleeve. Segmented seals are also acceptable for conduit 4-inch trade size and larger.
2. Sealing fittings for wall penetrations with water or soil on one side shall have seals installed at both ends of the conduit sleeve or core-drilled hole.
3. Where single conductors pass through a single sleeve, select materials to mitigate the effects of inductive heating.
4. Provide ground wire attachment bolts for manufactured sleeve assemblies.
5. Seals shall have fire ratings equal to the fire-resistant rating of the wall.

2.8 CONDUIT INTERIOR SEALING FITTINGS

A. Manufacturers:

1. Crouse-Hinds
2. O.Z. Gedney
3. Thomas & Betts

B. Conduit-to-Cable Sealing Fittings:

1. For exposed conduit ends without pull and junction boxes: Conduit fitting with synthetic elastomeric sealing gland with stainless steel compression plates drilled

- for the conduit ID and cable(s) OD, retained by threaded collar at the end of the conduit.
- 2. For exposed conduit ends entering pull or junction box: Conduit fitting suitable for installation of locknuts at conduit entry to sheet metal box, and bushing with synthetic elastomeric sealing gland with stainless steel compression plates drilled for the conduit ID and cable(s) OD, retained by threaded collar at the end of the conduit.
- 3. Seal shall be watertight at 20 feet of water pressure value.
- 4. Where single conductors pass through a seal, select materials to mitigate the effects of inductive heating.
- 5. Where bare stranded copper conductors pass through sealing fittings, place an exothermic weld in the stranded cable to prevent water from leaking through the strands.

2.9 CONDUIT EXPANSION AND DEFLECTION FITTINGS

- A. Manufacturers:
 - 1. Crouse-Hinds
 - 2. Spring City Electric
 - 3. O.Z. Gedney
 - 4. Thomas & Betts
- B. Conduit expansion and deflection fittings:
 - 1. Suitable for the anticipated expansion joint elongation and deflection at each expansion joint.
 - 2. Materials of construction: Hot dip galvanized ductile iron body, neoprene sealing sleeve, stainless steel clamps, tinned flexible copper equipment bonding jumper.

2.10 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 6. O-Z/Gedney; a unit of General Signal.
 - 7. RACO; a Hubbell Company.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet Division.
 - 10. Spring City Electrical Manufacturing Company.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Or Approved Equal.

- C. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.
- H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- I. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

2.11 FACTORY FINISHES

- A. Finish: For painted steel enclosures, provide manufacturer's standard commercial and industrial coating in ANSI 49 or 61 light gray color, or different color when required by the NEC.
- B. Field painting will be required for uncoated cast iron, steel, galvanized, zinc-coated, and factory primed surfaces. Products shall be degreased and made suitable for field painting prior to packaging for shipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATIONS

- A. Outdoor raceways, boxes, and fittings:
 - 1. Exposed: PVC-coated RGS.
 - 2. Concealed in hollow masonry exterior walls: PVC-coated RGS.
 - 3. Underground, Individual Conduit Runs: PVC-coated RGS.
 - 4. Underground Duct Banks: Schedule 80 rigid non-metallic conduit, except for the following:
 - a. 90-degree bends: PVC-coated rigid galvanized steel long radius factory-fabricated elbows.
 - b. Final 10 feet of conduit at duct bank entries into buildings: PVC-coated rigid galvanized steel.

- 1) Conduits containing branch circuit wiring from VFCs to motors: PVC-Coated rigid galvanized steel, Outdoors or Damp Locations: PVC-Coated rigid galvanized steel.
 - 2) Conduits containing shielded cables: PVC-Coated rigid galvanized steel.
 5. Hazardous Classified Locations: PVC-coated RGS conduit with fittings and boxes UL listed and labeled for the hazardous area classifications shown on the Drawings.
 6. Connections to transformers, motor-driven equipment, vibrating equipment, and equipment requiring position adjustment, e.g., rail-mounted motors: liquidtight flexible metal conduit in non-hazardous areas, explosion-proof flexible couplings in hazardous areas.
 7. Conduit Support Channels: stainless steel.
 8. Boxes and fittings: as described in each raceway sub-section, and recommended as suitable for the particular application by the manufacturer.
 9. Enclosures: refer to Division 26 Section "Electrical - General"
- B. Indoor raceways, boxes, and fittings:
1. Below floor slab in slab-on-grade construction: PVC-coated RGS conduit.
 2. Exposed: PVC-coated RGS in above-grade, exposed locations.
 3. Connections to transformers, motor-driven equipment, vibrating equipment, and equipment requiring position adjustment, e.g., rail-mounted motors: liquidtight flexible metal conduit in non-hazardous areas, explosion-proof flexible couplings in hazardous areas.
 4. Lighting fixture whips in Non-Hazardous Locations: LFMC.
 5. NEC Damp and Wet Locations: PVC-coated RGS
 6. Hazardous Classified Locations: PVC-coated RGS with fittings and boxes UL listed as suitable for the hazardous area classification shown on the Drawings.
 7. Conduit Support Channels in non-corrosive locations: Stainless steel.
 8. Conduit Support Channels in corrosive locations: fiberglass
 9. Boxes and fittings: as described in each raceway sub-section, and recommended as suitable for the particular application by the manufacturer.
 10. Enclosures: as specified in Division 26 Section "Electrical - General".
- C. Minimum Raceway Size: 3/4-inch trade size except that 1/2 inch trade size may be used for lighting whips above suspended ceilings.

3.2 INSTALLATION – GENERAL

- A. Deliver raceways, boxes, and fittings to job site in factory packaging. Store in clean, dry, weatherproof locations. Handle in accordance with manufacturer's recommendations.
- B. Install raceways, boxes, and fittings in accordance with manufacturer's installation instructions and NEC requirements as a minimum, and comply with the additional requirements described in this Section.
- C. Conduits shall be electrically and mechanically continuous, and suitable for use as an equipment-grounding conductor. Make up threaded joints wrench tight.
- D. Install and route emergency system raceways independently of other raceways systems, except where specific exceptions are permitted by the NEC.

- E. Fasten boxes in wet, outdoor, hazardous, corrosive and damp areas using external mounting feet. Do not drill through boxes.
- F. Comply with NEC requirements for sizing outlet and junction boxes to accommodate wires, splices, and devices.
- G. Bends and offsets between pull points shall not exceed a cumulative total of 270 degrees unless otherwise approved by the Engineer. Maximum distance between pull points in conduit systems inside buildings shall be 100 feet unless otherwise approved by the Engineer.
- H. Raceways shall be routed in conformance with the following guidelines:
 - 1. Run conduits exposed, concealed, and underground as indicated on the Drawings.
 - 2. The preferred location for horizontal conduit runs is just below the ceiling structural supports.
 - 3. Do not obstruct access to equipment for operation and maintenance. Coordinate conduit runs with the work of other trades. Plan conduit runs to avoid lighting fixtures, and leave space for easy access to HVAC equipment, motors, and duct access hatches and doors.
 - 4. Route conduits around doors, windows, hatches, louvers, and other building openings, and around range and fume hoods.
 - 5. Group conduits on horizontal trapeze hangers or on wall-mounted stainless steel channel where long horizontal runs are required.
 - 6. Do not run conduits through stairwells unless required for connection to equipment located in the stairwell.
 - 7. Maintain eight feet minimum clearance above finished floor wherever it is physically possible to do so. Comply with OSHA requirements for minimum headroom.
 - 8. Comply with raceway, boxes, and fitting details shown on the Drawings.
 - 9. Provide seals and flashings at roof penetrations in accordance with the recommendations of the roofing system supplier, or as shown on the Drawings.
 - 10. Where conduits enter the top of electrical equipment enclosures and control panels, install conduit interior sealing fittings to prevent entry of water and condensation from conduit.
- I. Cut conduits square with roller-wheel pipe cutter. Hacksaw cuts are acceptable only if the entire conduit is swabbed clean after cutting and threading is completed. Conduits cut in the field shall be threaded with sharp, standard NPT dies to achieve a fully cut tapered thread with a minimum of five full tapered threads at the end of the conduit. Running threads are not acceptable. Over- and under-threading are not acceptable. After threading, ream conduit ends, remove cuttings and debris from inside and outside of conduit, degrease, and apply cold spray-on zinc-rich paint.
- J. Conduit bends shall be made with conduit bending tools manufactured for the purpose. Comply with conduit and bending tool manufacturers' instructions. Use specially sized shoes in bending tools for PVC-coated rigid galvanized steel conduits.
- K. Do not cut or drill holes in structural beams and columns, or other structural members. Do not weld raceway supports to structural steel.

- L. Join raceways with fittings designed and approved for that purpose and make joints wrench tight. Comply with NEC requirements for minimum thread engagement in Hazardous Classified areas.
- M. Provide expansion, deflection, or expansion & deflection couplings at building expansion joints. Expansion and deflection fittings shall comply with UL 467 and UL 514B, and shall be suitable for the anticipated amount of movement and direction(s) of movement.
- N. Provide drain fittings at the first junction or pull box where conduits enter the building from outdoor and underground locations. Locate drains to permit observation of leakage without damage to electrical and mechanical equipment.
- O. Three-piece (Erickson) couplings shall be used where it is not possible to turn conduits to make up threaded joints. Threadless fittings are not generally acceptable. Application for permission to use threadless fittings at particular locations shall be made in writing to the Engineer, and threadless fittings shall not be used unless approved.
- P. Complete raceway installation before starting conductor installation.
- Q. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division "Thermal and Moisture Protection" Section "Penetration Firestopping".
- R. Boxes and poke-through assemblies in fire-rated floors and walls shall be UL-listed for the application. Comply with UL and manufacturer's requirements for installation.
- S. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- T. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box. Install bushings wrench-tight.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
 - 3. Install temporary closures to prevent foreign matter from entering raceways.
- U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- V. Install explosion-proof and moisture seal-off fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. At hazardous classified locations and where otherwise required by the NEC.

- W. Flexible Connections:
 - 1. Motors and equipment subject to vibration or movement: maximum 36 inches of LFMC up to 2 inch trade size, up to 72 inches in larger sizes, and explosion-proof couplings of adequate length for the installed conditions in hazardous (classified) locations.
 - 2. Install separate equipment bonding jumper across flexible connections where required by the NEC.
- X. PVC Coated Rigid Galvanized Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
- Y. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

3.3 INSTALLATION – EXPOSED RACEWAYS, BOXES AND FITTINGS

- A. Install raceways, boxes, and fittings exposed as indicated on the Drawings.
- B. Install exposed raceways parallel or at right angles to nearby surfaces or structural members.
 - 1. Run raceways together in-groups on common supports wherever possible.
 - 2. Do not use mechanical piping or ceiling supports to support conduit runs.
- C. Make concentric bends in parallel exposed conduit runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- D. Surface-mounted channel supports shall be 1-1/2 inch x 1-1/2 inch channel bolted to wall or ceiling with expansion anchors.
- E. Suspended (trapeze) channel supports shall be 1-1/2 inch x 1-1/2 inch channel suspended from minimum 3/8 inch stainless steel threaded rod. Fasten rods to structural steel with beam clamps or channel assemblies designed specifically for each application. Fasten threaded rods to concrete with expansion bolts and threaded rod hanger, or concrete channel inserts
- F. Keep raceways at least 6 inches away from parallel runs of flues and mechanical piping (including insulation). Install horizontal raceway runs above water and steam piping.
- G. Install electrical enclosures and cabinets plumb. Support at each corner.
- H. At building interior floor and roof penetrations, provide floor sleeves 2 inches above finished floor level with fire-rated conduit sealing fittings. Provide flashing at roof penetrations in accordance with roofing system manufacturer's recommendations.
- I. In chemical containment areas: Do not install junction boxes, pullboxes or enclosures below the top of the containment wall. Route raceways outside of the containment area to the extent possible.

3.4 INSTALLATION – CONCEALED RACEWAYS, BOXES AND FITTINGS

- A. Install raceways, boxes, and fittings concealed, including above suspended ceilings, in partitions, and within or below floor slabs, as indicated on the Drawings.
- B. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- C. Raceways embedded in slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete. Maintain 4 inch minimum spacing between conduit exterior surfaces.
 - 3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
- D. Stub-up connections: Extend conduits through concrete floor for connection to freestanding equipment. Install PVC-coated rigid steel conduit elbows with a flush-plugged coupling set flush with finished floor. Plugs shall be plastic, shall have slots for screw-drivers, and shall be within 1/8 inch of the finished floor surface. Extend conductors to equipment with rigid steel conduit. LFMC may be used above 12 inches (300 mm) above finished floor.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab. Use conduit expansion & deflection fittings in in-slab conduit runs when crossing structural joints at concrete equipment isolation pads.

3.5 INSTALLATION – UNDERGROUND CONDUIT

- A. Install raceways, manholes, handholes, and fittings underground as indicated on the Drawings.
- B. Comply with the requirements in Division 26 Section “Underground Ducts and Raceways for Electrical Systems”.
- C. At each duct bank entry into a building, install 10 feet minimum of PVC-coated rigid galvanized steel conduit. Install conduits with 6-inch dimension from finished face of wall to end of conduit for connection to junction or pull box.
- D. At conduit entries into buildings that are not part of concrete-encased duct bank construction, install wall sleeves or core drill conduit entrance holes and provide conduit seals and wire and cable seals to prevent water entry into buildings. Use sealing fittings described in Part 2 of this Section.
- E. When core drilling holes, use non-destructive testing method to located reinforcing steel, and core drill holes to avoid reinforcing steel.

3.6 PROTECTION DURING CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure coatings and finishes without damage or deterioration at time of Substantial Completion.
 - 1.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING & PAINTING

- A. Swab conduits clean after installation and plug ends until conductors are installed.
- B. Remove dust, construction debris, plaster and paint spatters from raceways, boxes, and fittings after all trades have completed their work, and prior to painting.
- C. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes, touch up damage, and prepare for finish painting in accordance with Division "Finishes" Section "Exterior Painting".

3.8 IDENTIFICATION

Identify raceways, boxes, and fittings as described in Division 26 Section "Electrical Identification for Electrical Systems".

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete underground distribution system including duct banks, pre-cast manholes, pre-cast pullboxes, and accessories, as shown on the Drawings and specified herein.
- B. Manholes and pullboxes shall be designed by a Professional Structural Engineer registered in the state where the manholes and pullboxes are to be installed.

1.2 RELATED WORK

- A. Work performed under this Section shall conform to applicable requirements in the following Specifications:
 - 1. Division "Existing Condition" Section "Select Fill" for crushed stone requirements.
 - 2. Division "Concrete" Section "Cast-in-Place Concrete" for concrete and reinforcing steel requirements.
 - 3. Division 26 Section "Raceways and Boxes for Electrical Systems" for conduit requirements.
 - 4. Division "Existing Condition" Section "Trenching, Compacting, and Backfilling" for excavation and backfilling.
 - 5. Division "Existing Condition" Section "Restoration of Surfaces" for restoration of surfaces.

1.3 REFERENCES

- A. Materials and installation shall be in conformance with the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. American Association of State Highway Transportation Officials (AASHTO)
 - 3. NFPA 70 - The National Electrical Code

1.4 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of duct banks, manholes, and pullboxes with yard piping, drainage, and exterior walls of buildings, tanks, basins, and other concrete structures.

1.5 SUBMITTALS

- A. Submittals shall conform to the General Conditions.

- B. Shop drawings: general arrangement, dimensions and weights and a complete bill of materials listing all components, supplemented by manufacturer's catalog data, for the following:
 - 1. Duct Banks: red die, duct (conduit) spacers, buried cable warning tape, reinforcing steel, concrete mix
 - 2. Manholes: precast manhole drawings, cast iron frames and covers, cable racks and support arms, and cable saddles with insulators
 - 3. Pullboxes: precast handhole drawings, cast iron frames and covers, cable racks and support arms, and cable saddles with insulators
- C. Pre-cast concrete structural design drawings shall be signed and sealed by a registered professional structural engineer licensed in the state where the manholes and pullboxes will be installed.
- D. Submit field test reports for the following:
 - 1. Concrete field test results
 - 2. Mandrel test results
 - 3. Grouting test report
- E. Submit qualifications and experience for the following:
 - 1. Concrete testing firm.

1.6 QUALITY ASSURANCE

- A. Qualifications
 - 1. Concrete Testing Firm Qualifications: Firm, laboratory, and field technicians certified by the American Concrete Institute.
- B. Source Limitations: Obtain manholes and pullboxes through one source from a single manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver manholes and pullboxes and accessories to designated storage areas at the construction site.
- B. Handle and install manholes and pullboxes and accessories in accordance with manufacturer's rigging and installation instructions.

1.8 WARRANTY

- A. Provide parts and labor warranty in conformance with the General Conditions.

PART 2 - PRODUCTS

2.1 PRECAST MANHOLES

- A. Precast manholes and accessories shall be as shown on the Drawings and specified herein. Minimum interior dimensions shall be as shown on the drawings.
- B. Precast Components
 - 1. Manholes and pullboxes shall consist of a lower precast section and an upper precast section, designed to fit together when stacked, with intermediate stackable sections as required to achieve the specified interior dimensions.
 - 2. Precast concrete sections shall be designed, constructed and reinforced in accordance with ASTM C478 and ASTM C890, with a minimum wall thickness of 6 inches and with joints having an "O" ring or square Buna N section ring seal.
 - 3. Base sections may have reinforced flat bottoms protruding beyond the outside face of the riser section, if needed to meet uplift criteria required by this Specification.
 - 4. Intermediate sections shall be provided as required to provide the required manhole height. Where bottom edge of manhole needs to be more than 10.0 feet below finished grade because of duct bank depth, manhole interior height shall be increased as required so that the top of the manhole is between 1 and 2 feet below finished grade.
 - 5. Concrete sections and cast iron covers shall be adequate to withstand AASHTO HS-20-44 wheel loading, unless otherwise indicated on the Drawings. All top sections shall have concentric or eccentric opening as shown on the Drawings.
- C. Cable Pulling Irons
 - 1. Pulling irons shall be located on the wall opposite each conduit opening. Irons shall be 7/8-inch diameter hot-dipped galvanized steel and shall be installed near floor level.
- D. Manhole Frames and Covers
 - 1. Manhole frames and covers shall be in accordance with ASTM A48, Class 30, and shall be as manufactured by the following:
 - a. Syracuse Castings
 - b. Neenah Castings
 - c. Or approved equal.
 - 2. Manhole covers shall be round. Square covers are not acceptable for manholes. Clear opening shall be as shown on the Drawings. Where no size is specified, clear opening shall be 36 inches.
 - 3. Covers shall be provided with a minimum of two pickholes and shall be solid unless otherwise noted. Frames and covers shall be adequate to bear AASHTO HS-20-44 wheel loads and shall be provided with machined bearing surfaces.
 - 4. Covers shall be cast with the word "ELECTRIC" at the center of the top surface of the cover, as indicated on the Drawings.
- E. Concrete Sealing
 - 1. Exterior walls and top of manhole shall be factory-coated with Chem Rex Sonneborn Hydrocide 700B or approved equal.

F. Conduit Entrances

1. Knockouts shall be provided at each wall where conduits enter the manhole. Size knockouts to accommodate spaced conduits plus 2 inches of concrete encasement.

G. Threaded Inserts

1. Threaded inserts 1/2-13 UNC (minimum) shall be provided at appropriate locations on each wall to fasten cable racks.

H. Provisions for ground rods

1. A 1-inch diameter hole shall be located in a corner of each manhole floor, approximately 12 inches from the walls.

I. Provisions for sump pump

1. A 12" diameter by 3" deep sump shall be located in the floor below the manhole opening.
2. The sump shall include a knockout for gravity drainage.

2.2 CABLE RACKS

A. Cable Racks (steel, with insulators)

1. Racks shall be heavy duty hot-dipped galvanized steel, Hubbell/Chance 1225 or equal. Arms shall be heavy duty hot-dipped galvanized steel with plastic coating and a length of at least 14 inches. Arms shall be Hubbell/Chance C203-0086 or equal.
2. Insulators shall be white porcelain, Hubbell/Chance 1121 or equal.

2.3 REINFORCED CONCRETE

- A. Concrete for duct banks shall be 3000 PSI mix with 3/8" maximum pea gravel aggregate and 7 to 8 in. slump.
- B. Reinforcing Steel shall be ASTM Grade 60 deformed bars.
- C. Reinforced concrete shall conform to the requirements in Division 3 Section "Cast-in-Place Concrete".

2.4 BURIED ELECTRIC LINE WARNING TAPE

- A. Tape shall be of the detectable type and shall consist of a 4 mil or heavier polyethylene tape with an aluminum foil detection strip. Tape shall be 6" wide. and shall be HTDU series as manufactured by the Panduit Corp. Cumming, GA, Thomas & Betts E-Z Code, Blackburn Detectable Tape or approved equal. Tape legends shall be black lettering on red background two lines wide, letters 2" tall. Text shall be: "CAUTION ELECTRIC LINE BURIED BELOW"

2.5 DUCT BANK CONDUIT SPACERS

- A. Underground duct bank conduit spacers shall provide stability and consistent separation of conduits within duct banks. Spacers shall be sized for the conduits with which they are used. They shall provide both vertical and horizontal spacing as shown on the drawings. Spacing between adjacent conduits shall be 2" unless otherwise shown on the drawings. Spacers shall be as manufactured by Carlon, Underground Devices, or equal.

2.6 SOURCE QUALITY CONTROL

- A. Factory Quality Certification: Submit copy of factory quality assurance certificate for each manufactured product.
- B. Factory Assembly: Precast manholes and pullboxes, and cast iron frames and covers, shall be manufactured in accordance with the factory quality management system.
- C. Factory Test: Submit factory test report for approval prior to shipment.

PART 3 - INSTALLATION

3.1 LAYOUT

- A. Do not install duct banks, manholes, and pullboxes on top of yard piping, except for right-angle crossings of duct banks and yard piping. Allow 1:2 cut slope for future excavation of underground piping. Notify the Engineer where these requirements cannot be met.

3.2 EXCAVATION

- A. Excavate and backfill for duct banks, manholes, and pullboxes in conformance with Division "Existing Conditions" Section "Trenching, Compacting, and Backfilling".

3.3 MANHOLES

- A. Precast manhole bases shall be installed level on a 24 inch deep layer of crushed stone, type "A" or type "B" material as defined in Division "Existing Conditions" Section "Select Fill". The stone shall extend 12 inches beyond manhole on all sides. Where an unstable condition exists, the Contractor shall excavate the unstable material and replace with compacted select fill.
- B. The weight of the empty manhole, plus the weight of the fill material above the manhole, shall exceed the maximum uplift force on the manhole. The maximum uplift force shall be calculated with the top of the manhole 1 ft below finished grade, with surrounding ground water at the same elevation as the top of the manhole, and the actual area of the base of the furnished manhole. If the weight of the proposed manhole is insufficient, a concrete slab shall be poured beneath the manhole and manhole anchored to the slab, or the manhole shall be furnished with an oversized base that extends outside of the manhole walls.

- C. Install concrete grade rings and grout as required to bring manhole cover flush with finished grade or paving.

3.4 DUCT BANKS

- A. Burial depth to the top of the top conduit(s) shall be a minimum of 24 inches unless otherwise indicated on the Drawings.
- B. Conduit spacers shall be used to separate concrete-encased underground conduits. Conduit spacers shall be installed at intervals of 8 feet or less. Spacers shall be provided for the top row of conduits to provide positive verification of required concrete depth.
- C. Place reinforcing steel and concrete in conformance with Division "Concrete" Section "Cast-in-Place Concrete". Place concrete directly into trenches without formwork where soil conditions permit. Provide formwork in soils where conditions are not suitable for using trench walls to form the walls of the duct banks.
- D. Rigid non-metallic conduits shall be terminated flush with manhole interior walls, with endbells manufactured by the conduit manufacturer.

- E. Bends in underground conduits shall have the following minimum bending radius:

Conduit Trade Size	Radius (inches)
Up to 2-1/2 inch	24
3 inch	36
4 inch	42
5 inch	48
6 inch	48

- F. Concrete encasement shall be provided as shown on the Drawings. A minimum of 3 inches of concrete shall be provided between outside edge of reinforcing and earth.
- G. Concrete delivery chutes shall be used so the fall distance between end of chute and duct bank is minimized. The sides of the duct bank shall be formed, or splashboards utilized (preferred), to divert concrete from trench sides and to avoid dislodging stones and soil.
- H. When placing concrete, encase from the fixed end of the duct toward the free end; do not encase from each end toward the center.
- I. Dye: Red dye, Spanish Sienna or equal, shall be floated into the top of the concrete encasement immediately after placing concrete. At the Contractor's option, 10 pounds dye per cubic yard concrete may be added to the concrete mix.
- J. Reinforcing

1. Each concrete-encased duct bank shall include ASTM Grade 60 reinforcing steel as shown on the Drawings. Where duct bank height or width is greater than 1 foot, additional reinforcing bars shall be provided so that maximum reinforcing spacing is 1 foot or less. Reinforcing ties or stirrups perpendicular to the conduits shall be provided as shown on the Drawings.
2. Where concrete encased conduits enter manholes and building walls, #4 dowels shall be installed between the duct bank and manhole or building wall, on 8 inch centers around the perimeter of the duct bank, to prevent conduit shearing. A minimum of 4 dowels shall be installed at each duct bank to manhole or wall interface.

K. Testing

1. Perform slump test, per ASTM C 143, at point of discharge, prior to beginning pour. Perform additional slump tests if water is added to concrete or if consistency appears to have changed.
2. Measure concrete temperature, per ASTM C 1064, hourly when air temperature is below 40 degrees F.
3. Measure air content, per ASTM C 173, for each day's pour.
4. Obtain one set of four test cylinders for each day's pour. Prepare, cure, and test cylinders per ASTM C31. Test one cylinder at 7 days and two cylinders at 28 days. Retain fourth cylinder until 28-day tests are accepted.

L. Cold Weather Concrete Placement

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures. Comply with ACI 306 and as follows.
2. When air temperature has fallen to, or inspected to fall to below 40 degrees F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 80 degrees F at point of placement.
3. Concrete shall not be placed on frozen subgrade or on subgrade containing frozen materials.
4. Calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators shall not be used.
5. Protect freshly poured concrete from freezing for a period of 7 days from pour. Submit proposed protection methods, for approval, at least two weeks in advance of pour.
6. Openings around conduits and duct banks shall be grouted.
7. Clean ducts after installation work is complete.
8. Mandrel test each duct with mandrel 1/4 inch smaller than conduit inside diameter and twice conduit diameter in length after cleaning is complete. If obstructions are encountered in existing ducts, notify the Owner and use progressively smaller mandrels until a mandrel can be pulled throughout the length of the duct. Submit mandrel test report to the Engineer for approval.
9. Install nylon fish tapes inside spare conduits. Install end caps on all conduits until cables are pulled.

M. Buried Electric Line Warning Tape

1. All buried conduits or groups of conduits shall have a detectable warning tape with metal strip buried 6 inches below finished grade and located directly over the centerline of the conduits.
2. Where the top of the highest conduit is more than 4 feet below grade, a second tape shall be buried 12 inches above the top of the highest conduit in the group. Where shown on the drawings, additional tapes shall be provided for duct banks wider than 30 inches.

3.5 CABLE RACKS

- A. Cable racks shall be provided as required in order to neatly rack cables along the manhole and handhole walls.

3.6 SEALING

- A. Small openings, such as those around ground rods and core-drilled holes for conduits, shall be filled with a silicon sealant.
- B. Exterior surface seal coating shall be touched up prior to backfilling in conformance with the coating manufacturer's instructions.

3.7 FIELD QUALITY CONTROL

- A. Perform concrete field tests as described herein and in conformance with Division "Concrete" Section "Cast-in-Place Concrete".
- B. Perform mandrel tests as specified herein.
- C. Submit test reports to the Engineer for approval.

3.8 PROTECTION

- A. Protect installed manholes, pullboxes, duct banks, and accessories from damage through Substantial Completion.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide electrical equipment nameplates, junction, pull and outlet box labels, raceway identification, wiremarkers, circuit identification, and warning signs for electrical equipment included in this Contract, as specified herein.
- B. This Section includes product and installation requirements for identification of electrical equipment, raceways, conductors, circuits, and outlets, and warning signs.

1.2 CODES AND STANDARDS

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. National Electrical Safety Code (NESC)
 - 2. Nationally Recognized Testing Laboratory (NRTL)
 - 3. NFPA 70E Standard for Electrical Safety in the Workplace®
 - 4. NFPA 79 Electrical Standard for Industrial Machinery

1.3 QUALITY ASSURANCE

- A. Manufacturers: Manufacturers shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer, and shall offer NRTL-listed and labeled products.
- B. Comply with NFPA and OSHA standards.

1.4 SUBMITTALS

- A. Make submittals in accordance with the General Conditions.
- B. Submittals shall include the following:
 - 1. Product data
 - 2. Complete list of all engraved nameplates.
 - 3. Sample of each of the following:
 - a. engraved equipment nameplate
 - b. computer-generated label
 - c. wiremarkers
 - d. safety signs
 - e. laminated instrument tags

PART 2 - PRODUCTS

2.1 EQUIPMENT NAMEPLATES

- A. Provide custom nameplates for all equipment listed in Part 3 of this Section.
- B. Nameplates shall have white letters engraved on black field, and shall be fabricated from 3-layer (black-white-black) thermoset plastic.
- C. Drill holes in nameplates to be fastened with tie-wraps as described in Part 3 of this Section.
- D. Nameplate lettering to be uppercase Roman block letters, minimum height as follows:
 - 1. MCCs, VFCs, panelboards, and transformers: 1/2 inch.
 - 2. Process Control Panels (unless factory-labeled): 1/2 inch.
 - 3. Valve actuators: 3/8 inch.
 - 4. Other equipment: 1/4-inch minimum.

2.2 PUNCHED TAPE LABELS (RECEPTACLE IDENTIFICATION)

- A. Punched Tape Labels for identification of receptacle circuits shall be 1/2 -inch black tape with white raised lettering.
- B. Manufacturer: Dymo or approved equal

2.3 WIREMARKERS

- A. Wiremarkers shall be computer-printed on white wrap-around paper with clear plastic protective "tail" and pressure-sensitive adhesive.
- B. Manufacturer: Brady, T&B, Panduit, or approved equal.

2.4 WIRE COLOR CODING

- A. Comply with NEC requirements for applying color-coding.
- B. Color Coding for service, feeder, and branch circuit wiring shall be as follows:
 - 1. 208 / 120 VOLTS A-B-C-N-G Black - Red - Blue - White - Green
 - 2. 240 / 120 VOLTS A-B-C-N-G Black - Red - Blue - White - Green
 - 3. 480 / 277 VOLTS A-B-C-N-G Brown - Orange - Yellow - Gray - Green
- C. Color coding for 120 VAC control wiring shall be as follows:
 - 1. Line - Black
 - 2. Neutral - White
 - 3. Ground - Green
 - 4. Switched - purple.

- D. Color coding for twisted shielded pair and twisted shielded triple signal cable conductors shall be the manufacturer's standard insulation colors.
- E. Color coding for DC power and control circuit wires:
 - 1. Negative polarity - Black
 - 2. Positive polarity - Red
 - 3. Switched - any color except black, red, white, green, and purple.

2.5 CONDUIT IDENTIFICATION

- A. Identify exposed unpainted conduits with a black indelible felt-tip marker.
- B. Identify exposed painted conduits with laminated tags fastened with nylon ties.

2.6 WARNING SIGNS

- A. Provide warning signs on electrical equipment, electrical room doors, and automatically started mechanical equipment in accordance with NEC and OSHA requirements.
- B. Electrical Room warning signs shall have the legend "Danger - High Voltage - Authorized Personnel Only".
- C. Automatically started motor-driven equipment shall have warning signs with the legend: "Warning - This Equipment Starts and Stops Automatically".

PART 3 - INSTALLATION

3.1 NAMEPLATES

- A. Fabricate equipment nameplates using the description and tag number nomenclature shown on the Drawings.
- B. Provide equipment nameplates for switchgear, switchboards, motor control centers, circuit breakers, transfer switches, panelboards, enclosed motor controllers and contactors, transformers, disconnect switches, motor control centers, valve actuators, and major fire alarm system components.
- C. Fasten nameplates to clean flat metal surfaces with pressure-sensitive two-sided adhesive tape and stainless steel screws.
- D. Fasten nameplates to valve actuators with nylon tie-wraps.

3.2 RECEPTACLES

- A. Label all receptacle circuits on device faceplates with punched (Dymo) tape.
- B. Provide the following information after load balancing is complete:
 - 1. Panel Designations (as shown on the Panelboard Schedules)
 - 2. Branch Circuit Breaker Number

3.3 WIRE COLOR CODING AND MARKING

- A. Color code each phase, neutral, and ground wire for service conductors, feeders, and branch circuits, at points of origin and termination of wires.
- B. Provide wiremarkers on all control and signal wires, as shown on the approved Loop Diagrams, Motor Control Wiring diagrams, and Control Panel field wiring diagrams.

3.4 CONDUIT IDENTIFICATION

- A. Clean unpainted conduit surfaces with mineral spirits. Write conduit number shown on the Conduit & Wire Schedules on each conduit at each exposed conduit termination point.
- B. Attached conduit identification labels to painted conduits with nylon tie-wraps.

3.5 WARNING SIGNS

- A. Fasten Electrical Room warning signs to doors with self-tapping tamper-resistant stainless screws.
- B. Suspend automatically started equipment warning signs above motors with chain hangers.
- C. Install warning signs required by OSHA in accordance with OSHA recommendations.

3.6 PANELBOARD DIRECTORIES

- A. During construction, provide handwritten panelboard schedules. After load balancing has been completed, provide complete typewritten directory with protective clear plastic cover for each panelboard, with name of load as shown on the Panelboard Schedules on the Drawings for each individual branch circuit.
- B. Lighting, receptacle, and appliance branch circuits shall be identified with room names in the panel directory.
- C. When branch circuits are relocated, the panel directory shall be updated to indicate functions and locations.
- D. When branch circuits are removed the panel directory shall be updated to indicate a spare
- E. Handwritten directory shall be provided until all circuits are connected. After panelboard acceptance testing and load balancing, install the permanent directory.

END OF SECTION

SECTION 26 05 73

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. Prepare and submit a draft Coordination Study for the selected electrical equipment manufacturer's proposed overcurrent protection devices for the project with the equipment shop drawings for review and approval.
- B. Incorporate the Engineer's comments on the Draft Coordination Study into a Final Coordination Study and submit the final study for approval.
- C. Coordination Studies shall include protection relay characteristic curves, transformer damage curves, wire and cable insulation temperature limits for cable sizes, fuse and circuit breaker characteristic fault-clearing curves, all in log-log graphical format. Using the IEEE recommendations in the IEEE Brown Book and the IEEE Buff Book, provide recommended overcurrent protection device tag names, catalog numbers, sizes and settings in tabulated format.
- D. The study shall include the power electric and emergency generators source overcurrent protective device characteristic curves.
- E. The Coordination Study shall include fault current calculations for three-phase, phase-to-phase, and phase-to-ground faults, beginning with the utility source contributions, and including service transformer, switchgear, motor control centers, panelboards, dry type transformers (under 600V), and associated wire and cable impedances that are relevant to the selection and coordination of overcurrent protection devices.
- F. Legally required standby generators overcurrent protection device settings shall be in conformance with NEC Article 701.
- G. Motor contribution shall be included in the fault current calculations.

1.2 DEFINITIONS

- A. In addition to the definitions in Division "Electrical" Section "Electrical", the following definitions apply to this Section:
 - 1. ATS: with respect to NETA, Acceptance Testing Specifications
 - 2. NETA: InterNational Electrical Testing Association

1.3 REFERENCE STANDARDS

- A. The Coordination Study shall comply with the following standards:
 - 1. ANSI/IEEE Std. C37 Family of Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses, with emphasis on the following:
 - a. ANSI/IEEE Std. C37.13 Low Voltage AC Power Circuit Breakers Used in Enclosures

- b. IEEE Std. C37.48.1TM -2002 IEEE Guide for the Operation, Classification, Application and Coordination of Current-Limiting Fuses with Rated Voltages 1-38 kV.
 - c. ANSI/IEEE Std. C37.46. Specifications for Power Fuses and Fuse Disconnecting
 - d. ANSI/IEEE Std. C37.50 Switchgear - Low-Voltage AC Power Circuit Breakers Used in Enclosures--Test Procedures
 2. ANSI/IEEE Std. C57 Family of Standards for Distribution, Power, and Regulating Transformers, with emphasis on the following:
 - a. IEEE C57.12
 - b. IEEE C57.96 Guide for Loading Dry-Type Distribution and Power Transformers
 3. ANSI/IEEE Std. C2-1997 National Electrical Safety Code
 4. IEEE 620-1996 IEEE Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines
 5. ICEA P-32-382-1999 Short-Circuit Characteristics of Insulated Cable
 6. ICEA P-45-482-1999 Short-Circuit Performance of Metallic Shields & Sheaths
 7. IEEE Std. 141-1993 IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book)
 8. IEEE Std. 242-2001 IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)
 9. IEEE Std. 399-1997 IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis (IEEE Brown Book)
 10. IEEE Std. 1015-1997 IEEE Recommended Practice For Applying Low Voltage Circuit Breakers Used In Industrial And Commercial Power Systems (IEEE Blue Book)
 11. NEMA Publication MG 1 Motors and Generators
 12. NFPA 70 - National Electrical Code

1.4 SUBMITTALS

- A. Qualifications and Experience:
 1. AHJ: The statutory Authority Having Jurisdiction as defined in NEC Article 100 for enforcement of legally required compliance to local codes, standards, and ordinances.
 2. Submit for approval the qualifications and experience of the coordination-study specialist who is proposed to be in responsible charge of the study. If the short circuit and coordination software reports contain such statements as "For review only by a registered professional engineer", the coordination study specialist shall be a registered professional engineer. Provide photocopies of the specialist's software manufacturer's training certificates. Include a minimum of 10 past projects completed by the proposed specialist within the last 2 years. Supply a list of past projects with supplier, contractor, and end-user names and contact telephone numbers.
- B. Submit the Draft Coordination Study for approval with the switchgear Shop Drawings.
- C. Submit the Final Coordination Study for approval.

- D. Submit certified “as-set” overcurrent protective device tabulations for the record. Include these settings in the Final Operation & Maintenance Manuals.

1.5 QUALITY ASSURANCE

- A. Software Qualifications: Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
- C. The overcurrent protective device settings in the approved Coordination Study shall become part of the database for Electrical Acceptance Testing.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following, or an approved equal:
 - 1. CYME International, Inc.
 - 2. EDSA Micro Corporation.
 - 3. Electrical Systems Analysis, Inc.
 - 4. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS:

- A. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.
- B. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

PART 3 - EXECUTION

3.1 PREREQUISITES

- A. Examine project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements (including proper selection of inverse, very inverse, or extremely inverse characteristic curve applications to different downstream devices) and other conditions affecting performance.
- B. Proceed with coordination study only after relevant data has been collected.

3.2 FAULT-CURRENT STUDY

- A. Study electrical distribution system from normal and alternate power sources throughout the existing and new electrical power distribution system shown on the single line

diagrams, and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum and minimum fault conditions.

- B. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- C. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
 - 1. ANSI/IEEE Std. C37.13
 - 2. ANSI/IEEE Std. C37.46.
 - 3. ANSI/IEEE Std. C37.50
 - 4. IEEE Std 399-1997 (IEEE Brown Book)
 - 5. [IEEE Std. 141-1993 (IEEE Red Book)]
 - 6. IEEE Std. 242-2001 (IEEE Buff Book)
 - 7. IEEE Std. 1015-1997 (IEEE Blue Book)
- D. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, phase-to-phase, and phase-to-ground faults.
- E. Equipment Short Circuit Ratings Evaluation Report: Evaluate the adequacy of overcurrent protective device fault-current ratings by comparing proposed devices with calculated fault-current momentary and interrupting duties.

3.3 COORDINATION STUDY

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections. Use equipment designation tags that are consistent with electrical distribution system single line diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of electrical utility service.
 - 3. Electrical distribution system diagram showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - c. Generator kilovolt amperes, size, voltage, and source impedance.
 - d. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
 - e. Bus ampere rating and impedance.
 - f. Motor horsepower and code letter designation according to NEMA MG 1
 - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Magnetic inrush current overload capabilities of transformers.

- c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Ratings, types, and settings of utility company's overcurrent protective devices.
 - e. Special overcurrent protective device settings or types stipulated by utility company.
 - f. Time-current-characteristic curves of devices indicated to be coordinated.
 - g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - h. Switchboards, panelboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.
- B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program.
- C. Recommendations shall comply with the following:
 - 1. IEEE Std. 242-2001 (Buff Book) recommendations for fault currents and time intervals.
 - 2. IEEE Std. 399-1997 (Brown Book) recommendations for analysis.
 - 3. NEC for overcurrent protection of circuit elements and devices.
- D. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current upon energization.
 - a. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242 (Buff Book). Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time

separation exists between series devices, including power utility company's upstream devices. Show the following specific information:

- a. One-Line Diagram showing devices related to the coordination curves.
 - b. Device tags.
 - c. Voltage and current ratio for curves.
 - d. Three-phase and single-phase damage curves for each transformer.
 - e. No-damage, melting, and clearing curves for fuses.
 - f. Cable damage curves for the specified cable
 - g. Transformer inrush points.
 - h. Maximum fault-current cutoff point.
3. Completed data sheets for setting other protective devices shown on the Drawings.

3.4 OVERCURRENT PROTECTIVE DEVICE SETTING

- A. Provide setting of any adjustable device in accordance with results of the coordination study. Engage the services of a factory-authorized service representative of the electrical distribution equipment manufacturer to supervise setting of overcurrent protective devices.

3.5 ARC FLASH ANALYSIS

- A. Perform arc flash hazard analysis to compute incident energy levels, proper ratings of PPE, NFPA 70E shock approach boundary distances at specified equipment locations, arc flash and shock protection boundaries, and warning label requirements. Incident energy and arc flash protection boundaries will be computed using IEEE Std. 1584, "IEEE Guide for Performing Arc Flash Hazard Calculations". The Contractor shall perform this study on all applicable exposure areas of the project. The arc flash hazard analysis shall also include identifying the available fault current at equipment buses as well as clearing time for applicable protective devices to determine proper personal protective equipment (PPE) requirements. The PPE determination will be based upon potential arc flash incident energy exposure levels and shall determine:
- a. Proper PPE required for each applicable piece of electrical equipment.
 - b. Working distance for each applicable piece of electrical equipment.
 - c. Incident energy level for each applicable piece of equipment.
 - d. Flash protection boundary for each applicable piece of equipment.
- B. Produce Arc Flash Hazard Warning Labels – The Contractor shall furnish arc flash hazard warning label information for each applicable piece of equipment (existing and new) in accordance with ANSI Z535.4, NEC 110.16 and NFPA 70E 130.3, UL 969 guidelines. The label information shall include:
1. Equipment description
 2. Voltage rating of equipment
 3. Flash Hazard Category
 4. Arc flash protection boundary (in.)
 5. Arc flash incident energy at the working distance (cal/cm²)
 6. Working distance (in.)
 7. Recommended protection including glove rating
 8. Limited, restricted and prohibited approach distances (in.)

9. Bus and protective device identifier
 10. Bolted fault current
 11. Date of issue
 12. Contractor contact information
- C. Arc flash labels should be provided in the following manner and all labels should be based on recommended overcurrent device settings and cannot be installed until the overcurrent device settings have been set correctly.
1. For each 480, 240 and 208 volt panel board and disconnect, one label should be provided.
 2. For each motor control center, one label should be provided per section
 3. For each low voltage switchboard, one label should be provided per section
 4. For each switchgear, one label should be provided per section
 5. For medium voltage switches, one label should be provided per section
 6. For buss tie breakers, one label should be provided based on dual feeds
- D. Install Arc Flash Hazard Warning Labels – The Contractor shall install the generated arc flash warning labels at the applicable equipment locations in accordance with NEC-2008 article 110.16.
- E. Signs shall be 7” x 9” in size and made of vinyl or as ordered by the Engineer.

END OF SECTION

SECTION 26 09 16

ELECTRICAL CONTROLS AND RELAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide electrical control components as shown on the Drawings and specified herein.

1.2 RELATED WORK

- A. The requirements in this Section also apply to the following Division 26 Sections:
 - 1. "Enclosed Controllers"
 - 2. "Motor Control Centers".
 - 3. "Packaged System Control Panels"
 - 4. "Variable Frequency Motor Controllers".

1.3 REFERENCES

- A. Equipment and installation shall be in conformance with the latest revisions of the following codes and standards:
 - 1. NFPA 70 – The National Electric Code (NEC)
 - 2. NFPA 79-2002 Electrical Standard for Industrial Machinery
 - 3. National Electrical Manufacturers Association - NEMA
 - 4. Underwriters Laboratories, Inc. - UL

1.4 SUBMITTALS

- A. Submittals shall conform to the General Conditions.
- B. Submit manufacturer's catalog data for each electrical control component, clearly marked to show what is proposed for this project. Cross out inapplicable data. Include manufacturers catalog data with the Shop Drawings for the equipment making reference to this Section.

PART 2 - PRODUCTS

2.1 ENCLOSURES

- A. Enclosure NEMA ratings and materials of construction shall be in conformance with Division 26 Section "Electrical - General".
- B. Enclosures shall have interior steel panel for device mounting. Interiors shall be painted white.

2.2 POWER SUPPLY DISCONNECTS

- A. 3-phase power supply disconnects shall be circuit breaker type, fully rated for the available fault current, with padlockable exterior operating handle.

- B. Single phase 120 volt power supply disconnecting means shall be a two-position OFF – ON selector switch.

2.3 CONTROL POWER TRANSFORMERS

- A. Control power transformers have 120 volts AC grounded single phase secondary for control circuits. Provide two primary fuses rated 100,000 amperes interrupting capacity at 600 volts, and one secondary fuse rated 300 volts. Fuses shall be sized in accordance with NEC requirements for the transformers sizes as provided.
- B. Minimum transformer sizes are shown on the Drawings. Provide larger transformers if necessary to accommodate the control circuit loads as actually installed plus 50VA spare capacity.

2.4 CONTROL RELAYS

- A. Control relays shall be 8-pin or 11-pin plug-in type. 120 VAC relays to be round pin type with indicator light. 24 volt relays to be blade type with indicating light. Provide restraining straps and relay bases recommended by the relay manufacturer.
- B. Control relays shall be provided with a check push-button for testing operation of the relay contacts.
- C. Control relays shall be provided with an integral indicating light showing the position of the relay (de-energized or energized).
- D. Contacts for all control and timing relays as shown on the Contract Drawings shall be silver cadmium oxide type with the following NEMA Standard ICS5 A300 contact ratings:
 - 1. 10 amps continuous, 1/3 HP at 120 VAC
 - 2. 10 amps continuous, 1/2 HP at 240 VAC
 - 3. 10 amps continuous at 24 VDC
- E. Solid State Timing Relays (TR) shall have adjustable time settings within adjustable time ranges.
 - 1. Time delay range shall be field-adjustable from 0.05 seconds to 999 minutes unless otherwise indicated on the Drawings.
 - 2. Timing relays shall have four selectable modes: On-delay, off-delay, one-shot and repeat cycle.
- F. Control relays shall be as manufactured by:
 - 1. Square D - Class 8501 - Type K for control relays and Square D - Class 9050 Type JCK70
 - 2. Equal by Idec
 - 3. Equal by Potter & Brumfield
 - 4. Or approved equal

2.5 PUSHBUTTONS, SELECTOR SWITCHES, INDICATING LIGHTS

- A. General

1. All control devices shall be heavy duty, watertight and oiltight, with die cast operator bodies of nominal 1-1/4 inch (30.5 mm) diameter , and molded modular type contact for blocks.
2. All control devices exposed to the environment shall be rated NEMA 4 and NEMA 13. Devices in corrosive locations shall be non-metallic type rated NEMA 4X. Devices in hazardous locations shall be rated NEMA 7.
3. Colors shall conform to NFPA 79-2002 Electrical Standard for Industrial Machinery.
4. Pushbuttons, selector switches, and indicator lights shall be suitable for operation on 120 volts 60 Hz unless otherwise indicated.

B. Pushbuttons

1. Pushbuttons shall have button operator with color inserts and guards, engraved legend plates, and contact blocks as required for the specified functionality.
2. Emergency Stop Pushbuttons shall be two-position maintained-contact push-pull type with red mushroom operator.
3. Start pushbuttons shall be fully guarded, with green color insert, and momentary contacts.
4. Stop pushbuttons shall be unguarded (button extends above ring), with red color insert, and momentary contacts.
5. Stop lockout pushbuttons shall be maintained contact type, push to stop/pull to enable, with features to allow padlocking in the stop position.

C. Selector Switches

1. Selector switches shall have gloved hand type operators, engraved legend plates, and contact blocks as required for the specified functionality.

D. Indicator (Pilot) Lights

1. Indicator lights shall be wired for push-to-test operation.
2. Indicator lights shall be LED type unless otherwise indicated.
3. Indicator lights shall be provided with color caps matching the LED color.
4. Indicator lights shall be provided with engraved legend plates indicating function.

E. Manufacturers

1. Siemens (Furnas)
2. General Electric CR 2940
3. Square D Class 9001, Type K
4. Allen Bradley
5. Or approved equal.

2.6 ANTI-CONDENSATION HEATERS

- A. Anti-condensation heaters shall be 120 VAC, in enclosure, with adjustable thermostat. Integral heat circulating fans shall be provided for anti-condensation heaters mounted in outdoor enclosures.

2.7 CONTROL STATIONS

- A. Control Stations shall have enclosure ratings and types in conformance with Division 26 Section "Electrical - General", with pre-punched openings for pushbuttons, indicator lights, and selector switches.

2.8 TERMINAL BLOCKS

- A. Provide terminal blocks for all field wiring connections. Terminal blocks shall be rail-mounted, 600 volt, 30 amp, nylon, with recessed tubular screw terminals suitable for #12 through #18 AWG stranded copper wire terminations, "fingersafe" to DIN57470.
- B. Terminal blocks shall be Square D "GM" series, or approved equal.

2.9 ELAPSED TIME METERS

- A. Elapsed time meters shall be 6-digit 0-99999.9 hours 120 VAC, NEMA 4 and 12 (with gasket), quartz crystal based, 2.8 inch round flange 3-hole mount for 2 inch cutout, ENM Counting Instruments Series T50 Quartz AC Hour meter, or approved equal.

2.10 DIGITAL INDICATORS

- A. Indicators shall operate on 120 VAC, single phase power source. Provide 24 volt control power transformer for units requiring 24 volt power supply.
- B. Indicators shall have an operating temperature range of 0 deg. C to +50 deg. C.
- C. Digital indicators shall provide 24 VDC power supply for the transmitters, shall scale and display a 4-20 mA dc input signal in actual Engineering Units (feet of water, psi, gpm, MGD etc.), and shall have the following features:
 - 1. NEMA 4 rating
 - 2. Power supply: 115 VAC
 - 3. 7 digit red LED display 1 inch high (nominal)
 - 4. 2 adjustable current trip alarm outputs
 - 5. 4-20 mA retransmitted signal from the instrument
 - 6. Provide mounting kit
 - 7. Manufacturer/Model: Magnetrol 009-5765-506, MorHEAT N1500, Redlion, or approved equal.

2.11 INTRINSICALLY SAFE RELAYS AND BARRIERS

- A. Intrinsically safe relays shall be U.L. listed for Class I Division 1 Groups C and D Hazardous (Classified) Locations, similar and equal to Gems Sensors and Controls "Safe-Pak"
- B. Intrinsically safe barriers for 4-20 mADC signals shall be U.L. listed for Class I Division 1 Groups C and D Hazardous (Classified) Locations, similar and equal to Gems Sensors and Controls "Single Channel Zener Barriers".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install control devices in conformance with the manufacturer's installation instructions and recommendations, and as shown on the Drawings.

3.2 ACCEPTANCE TESTS

- A. Acceptance testing shall be performed as specified in the individual Specification Sections utilizing the control components.

END OF SECTION

SECTION 26 09 20

PACKAGED SYSTEM CONTROL PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide factory-wired control panels, and factory-installed wiring in conduit, for packaged mechanical equipment and systems specified in other Divisions of the Specification, in conformance with this Section.
- B. This Section describes general requirements for industrial control panels and associated wiring in conduit for “packaged”, “skid-mounted”, and “factory-assembled” systems.

1.2 RELATED WORK

- A. Related Sections include the following Division 26 Sections:
 - 1. "Low-Voltage Electrical Power Conductors and Cable" for wire and cable requirements.
 - 2. "Raceway and Boxes for Electrical Systems" for conduits, boxes, and fittings requirements.
 - 3. "Electrical Controls and Relays" for control power transformers, relays, pushbuttons, indicator lights, selector switches, running time meters, digital indicators, anti-condensation heaters, terminal blocks, and other control devices.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standard Institute - ANSI
 - 2. American Society of Testing Materials - ASTM
 - 3. Institute of Electrical and Electronic Engineers - IEEE
 - 4. International Building Code and Local Building Codes
 - 5. National Electrical Code - NEC
 - 6. National Electrical Contractors Association - NECA
 - 7. National Electrical Manufacturers Association – NEMA
 - 8. National Fire Protection Association - NFPA
 - 9. Underwriters Laboratories, Inc. - UL
- B. Equipment furnished under this Contract shall conform to one of the following requirements:
 - 1. Listed and labeled by a Nationally Recognized Testing Laboratory to UL standards applicable to the equipment.
 - 2. If such listing and labeling is not provided, the Contractor shall pay all fees and costs associated with a special inspection that is in conformance with the requirements of the Authority Having Jurisdiction (the AHJ as defined in Division 26 Section “Electrical - General”).

- C. Industrial control panels shall be NRTL-listed and labeled to UL 508A - Industrial Control Panels.

1.4 QUALITY ASSURANCE

- A. Uniformity: Unless otherwise specified equipment or material of same type of classification, used for the same purpose shall be products of same manufacturer. All material shall be new and of the current design.
- B. Conform to NEC requirements for the Damp, Wet, and Hazardous (Classified) Location requirements for the equipment in its installed location.

1.5 SUBMITTALS

- A. Submittals shall conform to the General Conditions.
- B. The control panel fabricator shall provide a complete set of control panel drawings and related documentation for use by the equipment installer and Owner's maintenance staff for installation of the equipment, interconnection with associated equipment, and troubleshooting. This technical documentation shall generally conform to NFPA 79 Electrical Standard for Industrial Machinery, using ANSI standard symbols.
- C. Control Panel Shop Drawings shall include the following:
 - 1. One-line and 3-line power wiring diagrams
 - 2. Control panel general arrangement drawings, including plans, sections, elevations, internal layout, and door layout.
 - 3. Complete bill of materials indexed to the control panel general arrangement drawings and wiring diagrams, with manufacturer's product data for each component. Indicate selections on manufacturer's catalog data sheets, and cross out inapplicable data.
 - 4. Schematic wiring diagrams, including control elementary (ladder) diagrams, showing the following:
 - a. Schematic (ladder) line numbers
 - b. Relay contact reference line numbers (underline NC contacts)
 - c. Wire numbers
 - d. Device numbers
 - e. Terminal numbers
 - f. Annotations of control switch action and relay logic names
 - 5. Equipment that includes fabricator installed Programmable Logic Controllers (PLCs) shall also include the following additional documentation:
 - a. PLC input and output layout
 - b. PLC termination diagram
 - c. PLC logic in fully annotated elementary (ladder) diagram format.
 - 6. UL 508A (Industrial Control Panels) listing certificate.
- D. Provide manufacturer's product data for the following:
 - 1. All control panel components.
 - 2. Nameplate titles.

- E. Operation and Maintenance Manuals shall include the following:
1. Record (as-built) copies of all reviewed shop drawings.
 2. Wiring diagrams incorporating all field changes and Engineer's comments.
 3. Manufacturer's instructions on care and operation of equipment.
 4. Warranty certificates.
 5. Spare parts list.
 6. Complete typewritten operating instructions, covering all system descriptions and operation, emergency operating instructions and precautions.
 7. Name, address and telephone number of supplier or representative of manufacturer for each item of equipment in Contract.
 8. Bind above items (all unused, clean, and legible) in common folder or heavy notebooks cover and submit to Engineer for before request for final acceptance.

PART 2 - PRODUCTS

2.1 ENCLOSURE TYPES AND RATING

- A. Packaged System Control Panel enclosures shall be suitable for the installed location, and shall conform to the NEMA enclosure requirements specified in Division 26 Section "Electrical - General".

2.2 POWER SUPPLY

- A. Packaged equipment shall be provided with a single power connection point unless otherwise indicated. The equipment manufacturer or vendor shall provide all power distribution equipment, overcurrent, and short circuit protection required to meet NEC and UL 508A requirements.
- B. Packaged system control panel overcurrent protective devices shall be rated 42,000 amps RMS symmetrical at 480 VAC, three phase, 60 Hertz or 10,000 amps RMS symmetrical at 120/240 VAC, single phase, 60 Hertz as applicable.
- C. For combination starters and industrial control panels with motor controllers operating on 3-phase power supplies, provide main circuit breaker disconnecting means with flange-mounted external operating handle, padlockable in the OPEN and CLOSED positions.
- D. Industrial control panels with 120 volt single phase 60 Hz power supplies shall have a CONTROL POWER OFF – ON selector switch and white POWER ON indicator light mounted on the enclosure door.

2.3 MOTOR CONTROLLERS

- A. Motor starters, where required, shall be NEMA rated, minimum Size 1. Motor starters shall have the same continuous current ratings as NEMA size starters. Motor starters shall include motor circuit breakers, contactors, and overload relays in conformance with the combination motor starter requirements in Division 26 Section "Enclosed Controllers".
- B. When required by the application, variable frequency motor controllers shall be mounted in control panel enclosures that are designed to dissipate the heat gain from the variable frequency controllers without increasing the temperature inside the controller above the

operating range of the control components mounted inside the enclosure. Control panel enclosures with NEMA 4 and 12 ratings shall be fitted with air conditioning units if necessary to meet this requirement. Variable frequency controllers shall be in conformance with the Division 26 Section "Variable Frequency Controllers."

2.4 ELECTRICAL CONTROL COMPONENTS

- A. Control power transformers, relays, pushbuttons, pilot lights, selector switches, elapsed time meters, digital indicators, terminal blocks, anti-condensation heaters, intrinsically safe relays and barriers, and other control components shall be in conformance with Division 26 Section "Electrical Controls and Relays".

2.5 WIRE MANAGEMENT

- A. Control panels shall include plastic wireways with removable covers for organizing and supporting internal wiring, and insulated "finger-safe" terminal blocks for termination of conductors.
- B. Control panel internal wiring shall be identified on each end with wire numbers corresponding to the control panel elementary ("ladder") diagrams. Wire labels shall conform to Division 26 Section "Identification for Electrical Systems".
- C. DC signals, 120 VAC, 480 VAC, intrinsically safe, and other wiring shall be kept separate and in conformance with NEC requirements, and wired to separate terminal strips. Low voltage signal wiring (e.g. 4-20 mA) shall be kept separate from 120 volt or higher control and power wiring.
- D. Provide adequate space adjacent to the separate 480 VAC, 120 VAC, 4-20 mADC, and intrinsically safe terminal strips for incoming conduits.

2.6 INTERFACE

- A. Provide only 4-20 mA analog inputs and outputs, and NEMA Standard ICS5 A300 Form C (SPDT) dry contact discrete inputs and outputs, for hard-wired control panel interface with other devices and systems. Voltage-based analog signals are not acceptable for connections to devices outside of the control panel.
- B. Provide intrinsically safe relays and barriers for connection to control devices mounted in Hazardous (Classified) Locations.
- C. Provide digital interfaces when specified in the Sections making reference to this Section.

2.7 IDENTIFICATION

- A. Each control panel control component shall be identified with an engraved phenolic nameplate matching the designation on the bill of materials, in conformance with Division 26 Section "Identification for Electrical Systems".

2.8 FACTORY-INSTALLED RACEWAYS, BOXES, AND FITTINGS

- A. All wiring external to the Control Panel enclosure shall be installed within raceways, boxes, and fittings conforming to Division 26 Section "Raceway and Boxes for Electrical Systems".
- B. Provide conduit hubs for top conduit entries to Control Panels.
- C. Junction, pull, and outlet boxes shall be sized in accordance with the NEC, and shall have NEMA enclosure types in accordance with Division 26 Section "Electrical - General". Stamped steel boxes, boxes with knockouts, PVC conduit, flexible metallic conduit (Greenfield), and EMT are not acceptable for raceways, boxes, and fittings.
- D. Raceways shall be routed such that equipment is readily accessible, and removable for maintenance. Do not run conduit through areas that serve as walkways. Conform to NEC requirements for "readily accessible".

2.9 FACTORY-INSTALLED WIRE AND CABLE IN CONDUIT

- A. Provide wiring in conformance with Division 26 Section "Low-Voltage Electrical Power Conductors and Cable", installed in raceways, boxes and fittings as described above.
- B. Control wiring shall be #14 AWG (minimum) or as required on the NEC, stranded copper type MTW (machine tool wire).
- C. 4-20 mA signal wiring shall be #16 STP (shielded twisted pair), with 300 volt or 600 volt insulation to meet NEC requirements for conductors of different systems in common enclosures.
- D. All wires shall be identified on each end with wire numbers corresponding to the schematic drawings. Wire labels shall conform to Division 26 Section "Identification for Electrical Systems".
- E. An NEC-sized equipment grounding conductor shall be provided inside each AC circuit conduit.
- F. Connections to screw type terminals shall be made by means of flanged spade or indented spade type compression connectors, similar and equal to T&B Skakon.

PART 3 - EXECUTION

3.1 FACTORY WORKMANSHIP

- A. Control panels, raceways, wiring, supports, control devices, and motors shall be factory-installed in a neat and workmanlike manner in accordance with the requirements of this Section and NEMA and NECA installation standards. Any electrical wiring not installed in conformance with this Section shall be removed and reinstalled in the field by the Contractor no additional cost to the Owner.

END OF SECTION

SECTION 26 22 13

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide energy-efficient dry type transformers (600V and less) as shown on the Drawings and specified herein.

1.2 RELATED DOCUMENTS

- A. Dry-type transformer related requirements are also specified in the following Division 26 Sections:
 - 1. Panelboards for secondary overcurrent protection.
 - 2. "Low-Voltage Electrical Power Conductors and Cable" for wiring.
 - 3. "Raceway and Boxes for Electrical Systems" for conduit and fittings.
 - 4. "Grounding and Bonding for Electrical Systems" for transformer grounding.

1.3 SUMMARY

- A. This Section describes requirements for dry type distribution and power transformers with primary and secondary windings under 600V.

1.4 DEFINITIONS

- A. In addition to the definitions in Division 26 Section "Electrical", the following definitions apply to this Section:
 - 1. AC: alternating current
 - 2. Energy efficient transformer: transformer kVA rating is at lower than maximum temperature rise for a particular insulation class
 - 3. FCAN: full capacity above normal
 - 4. FCBN: full capacity below normal
 - 5. Standard transformer: transformer kVA rating is at maximum temperature rise for a particular insulation class

1.5 QUALIFICATIONS

- A. The manufacturer of the core and coil shall procure all other transformer components, and shall assemble, factory test, and prepare the transformer for shipping.
- B. The transformer manufacturer shall have quality certification to ISO 9000:2000 or equivalent.

1.6 REFERENCE STANDARDS

- A. Comply with the following standards in effect at the time of bid submittal:
 - 1. IEEE 259-1999 IEEE Standard Test Procedure for Evaluation of Systems of Insulation for Dry-Type Specialty and General Purpose Transformers

2. IEEE C57 Family of Guides and Standards for Distribution, Power, and Regulating Transformers, with emphasis on the following:
 - a. IEEE C57.12.70 IEEE Standard Terminal Markings and Connections for Distribution and Power Transformers
 - b. IEEE C57.12.80 IEEE Standard Terminology for Power and Distribution Transformers
 - c. IEEE C57.12.91 IEEE Standard Test Code for Dry-Type Distribution and Power Transformers
 - d. IEEE C57.96-1999 IEEE Guide for Loading Dry-Type Distribution and Power Transformers
 - e. IEEE C57.105-1978 (R1999) IEEE Guide for Application of Transformer Connections in Three-Phase Distribution Systems
 - f. IEEE C57.110-1998 IEEE Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents
3. NEMA Standard ST-20
4. NEMA Standard TP-1 for Energy-Efficient Transformers
5. NEMA Standard TP-2 for Test Requirements For Energy Efficient Transformers
6. NFPA 70 National Electrical Code
7. UL Standard 1561
8. Other applicable NRTL Standards

1.7 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions:
 1. Temperature range, humidity range, and elevation are specified in Division 26 Section "Electrical - General".

1.8 SUBMITTALS

- A. Preconstruction Submittals
 1. Qualifications data for Testing Firm and Testing Firm's Field Supervisor.
 2. Qualification data for Manufacturer, including Quality Certification.
- B. Shop Drawings
 1. Compliance Statement
 2. Specially prepared shop drawings including the following:
 - a. Equipment nameplate data and electrical ratings
 - b. Weights and overall dimensions
 - c. General arrangement, section view, and sub-assembly drawings cross-indexed to a complete bill of materials listing all components and part numbers
 - d. Connection diagrams and details.
 - e. Location of field wiring & conduit connections
 3. Include Product Data Sheets with Shop drawing submittals.
- C. Plans, elevations, sections, and details showing installation dimensions, required clearances for access, operation and maintenance, installation details, and special instructions.
- D. Product Data Sheets

1. Technical data sheets, marked to show equipment selected for this project.
 - E. Test Reports
 1. Factory test reports
 2. Acceptance test reports
 - F. Manufacturer's Instructions
 1. Shipping, receiving, handling, rigging, storage and setting instructions, recommendations, cautions, and warnings. Foundation details showing concrete and anchor bolt details.
 - G. Manufacturer's Field Reports
 1. Inspection of equipment installation (prior to energization and startup) report
 2. Equipment startup and functional testing report
 - H. Operation and Maintenance Data
 1. Operation and Maintenance Instructions: For equipment and accessories, including pre-energization tests and checks, initial energization procedure, exploded views of major assemblies and sub-assemblies indexed to parts lists, maintenance instructions and recommended maintenance intervals, troubleshooting procedures, and contact details for spare parts purchase and technical support.
 - I. Closeout Submittals
 1. Follow up service reports
 2. Thermographic scan reports
 3. Warranty
 - J. Additional requirements are specified in Division 26 Section "Electrical - General".
- 1.9 QUALITY ASSURANCE
- A. Quality Certification: The transformer manufacturer shall have quality certification to ISO 9000:2000 or an equivalent Quality Management System acceptable to the Engineer. Evidence of certification shall be submitted with equipment shop drawings.
 - B. Electrical Testing Agency Qualifications: An independent electrical testing agency, with the experience and capability to conduct the specified testing, and is a member company of the InterNational Electrical Testing Association.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
 - C. Comply with NFPA 70 National Electrical Code requirements, and Reference Standards listed herein.

1.10 COORDINATION

- A. Coordinate layout and installation of transformers with the work of other trades, including mechanical equipment and piping, ceilings (where applicable), and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- B. Coordinate size and location of concrete equipment pads with the work of other trades. Follow the switchgear manufacturer's installation instructions. Set inserts into concrete formwork prior to placement of concrete, and check that inserts remain in place during placement of concrete. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton / Cutler-Hammer
 - 2. General Electric
 - 3. Square D / Groupe Schneider NA
 - 4. Asea Brown Boveri, Ltd.
 - 5. Or approved equal

2.2 DRY-TYPE DISTRIBUTION AND POWER TRANSFORMERS

- A. Dry type distribution transformers shall have the following ratings:
 - 1. Capacity (kVA) as shown on Drawings at 30 deg. C average, 40 deg. C max. ambient air temperature in accordance with IEEE C57.96-1999
 - 2. 220 deg. C insulation system.
 - 3. Insulation Temperature Rise: 115 deg C, maximum rise above 40 deg C., energy-efficient type.
 - 4. Primary voltages as shown on Drawing, three phase delta 60 Hz primary
 - 5. Secondary voltages as shown on Drawing, solidly grounded wye secondary
 - 6. Four - 2.5% FCAN primary taps
 - 7. Four - 2.5% FCBN primary taps
 - 8. NEMA 2 enclosure
- B. Dry-type two-winding transformers shall be in compliance with applicable portions of NEMA ST 20, IEEE C57.12.01, and UL 1562.
- C. Dry-type two-winding transformer minimum efficiencies shall comply with NEMA TP1 Table 4-2 requirements. A portion of the Table is shown below for reference:

Single Phase kVA	Efficiency	3 Phase kVA	Efficiency
15	97.7%	15	97.0%
25	98.0%	30	97.5%

37.5	98.2%	45	97.7%
50	98.3%	75	98.0%
75	98.5%	112.5	98.2%
100	98.6%	150	98.3%
167	98.7%	225	98.5%
250	98.8%	300	98.6%

- D. Primary and Secondary Connections: Air terminal compartment with removable panel. Tin-plated copper bar with predrilled NEMA spade terminals.
- E. Insulation Materials: IEEE C57.12.01, NEMA ST20, non-hygroscopic, thermosetting varnish.
- F. Core and Coil Assemblies: Transformer coils shall be aluminum wound on a core of electrical grade steel with high magnetic permeability and insulated laminations. Core and coil assembly shall be mounted on a structural steel base, which shall be isolated from the rest of the structure by vibration pads.
- G. Grounding: Provide equipment grounding terminal welded to the core support structural steel. Provide tin-plated braided copper grounding jumpers between the core and coil assembly and the enclosure ground. Provide tin-plated secondary neutral terminal with provisions for connecting a grounding electrode conductor directly to the neutral terminal, and a copper bonding jumper to the transformer equipment (enclosure) ground.
- H. The maximum temperature of the top of the enclosure shall not exceed 50 deg. C rise above 40 deg. C ambient.
- I. Enclosure shall be fabricated from heavy gauge steel, cleaned, degreased, primed and painted with electrostatic process polyester powder coat, ANSI ANSI 61 light gray.

2.3 IDENTIFICATION

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems".

2.4 QUALITY ASSURANCE

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to NEMA ST-20 for standard transformers, and NEMA ST-20 and TP2 for energy-efficient transformers.

2.5 TOUCHUP PAINT

- A. Furnish 0.5 pint (250 mL) of touchup paint for each transformer provided.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and wiring will not have to cross section barriers to reach load or line lugs.
- B. Examine walls, floors, roofs, and concrete equipment pads for suitable mounting conditions where transformers will be installed.
- C. Verify that equipment grounding conductors are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at transformer.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Store transformers in clean dry indoor rooms with a temporary dehumidifier and electric heating to maintain the storeroom between 5 and 40 deg. C with humidity less than 90%. Comply with manufacturer's additional written instructions for storing and periodic inspection and testing. Transformers shall be megger-tested monthly during storage. Units that have absorbed excessive moisture due to poor humidity and temperature control shall be returned to the manufacturer for drying-out and re-establishing acceptable megger test values at no additional cost to the Owner.

3.3 INSTALLATION

- A. Transformers 75 kVA and larger shall be floor-mounted on concrete equipment pads. 45 kVA and smaller transformers shall be floor-, wall-, or ceiling-mounted, as shown on the Drawings.
 - 1. Anchor transformers according to manufacturer's written instructions.
 - 2. Construct concrete equipment pads of dimensions indicated, but not less than 2 inches larger in both directions than supported unit and 4 inches high indoors.
 - 3. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."
 - 4. Use steel channel and ½ inch diameter (minimum) threaded rods for wall and ceiling support assemblies.
 - 5. Install dowel rods to connect concrete equipment pads to structural concrete floor. Unless otherwise indicated on the Drawings, install dowel rods on 12-inch (300-mm) centers around full perimeter of pad. Install epoxy anchor bolts for supported equipment.
 - 6. Place and secure anchorage devices. Use equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and the NEC.

3.4 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems".

3.5 CONNECTIONS

- A. Ground equipment in conformance with Division 26 Section "Grounding and Bonding for Electrical Systems".
- B. Connect wiring in conformance with Division 26 Section "Low-Voltage Electrical Power Conductors and Cable".
- C. Provide primary tap connections as necessary to achieve rated secondary voltage.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of transformers. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports.
 - 1. After installing transformers but before primary is energized, verify that grounding system is tested at specified value or less.
 - 2. Perform electrical test and visual and mechanical inspection described in the following NETA Acceptance Testing Specification Inspection and Test Procedures applicable to the equipment furnished for this project:
 - 3. 7.2.1.1 "Transformers, Dry-Type, Air-Cooled, Low-Voltage, Small"
 - 4. 7.2.1.2 "Transformers, Dry-Type, Air-Cooled, Large"
- B. Certify compliance with test parameters.
- C. Remove malfunctioning units, replace with new units, and retest as specified above.
- D. Test Reports: Prepare written reports to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide panelboards as shown on the Drawings and specified herein.
- B. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and receptacle branch-circuit panelboards.
 - 3. Load centers.

1.2 RELATED DOCUMENTS

- A. Additional requirements are described in the following Division 26 Sections:
 - 1. "Grounding and Bonding for Electrical Systems" for grounding requirements.
 - 2. "Surge Protective Devices" for distribution panelboard TVSS units.

1.3 DEFINITIONS

- A. In addition to the definitions in Division 26 Section "Electrical - General", the following definitions apply to this Section:
 - 1. EMI: Electromagnetic interference
 - 2. GFCI: Ground-fault circuit interrupter
 - 3. RFI: Radio-frequency interference
 - 4. RMS: Root mean square
 - 5. AFCI: Arc fault circuit interrupter

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage surge suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment, submit the following:
 - 1. Specially prepared drawing for each panelboard showing dimensions, busbars, circuit breakers, doors and trim, latches and locking devices, and complete bill of materials listing all components. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboard and overcurrent protective devices
 - d. UL listing for series rating of installed devices.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power (for all panelboards) and control wiring (for panelboards with control devices).
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. Include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of adjustable overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association (NETA) or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70
- F. Comply with UL 67 and UL 50
- G. When used as service equipment the panelboard shall be UL label for Service Equipment..

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the ambient temperature, altitude, and humidity conditions described in Division 26 Section "Electrical - General".
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than fifteen days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Key all panelboards alike
 - 3. Arc flash warning label as specified in latest edition of NFPA 70
 - 4. 20% spare breakers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corporation; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Protection Div.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D.
 - e. Or approved Equal

2.2 MANUFACTURED UNITS

- A. All panelboards shall be dead front design

- B. Enclosures: Surface mounted cabinets in conformance with NEMA PB 1.
 - 1. Rated for environmental conditions at installed locations, and in conformance with Division 26 Section "Electrical - General" enclosure requirements.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Provide full height piano hinge.
 - 4. Gutter Extension and Barrier: Same gauge and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections..
 - 5. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
 - 6. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
 - 7. The manufacturer's nameplate shall be of corrosion resistant metal such as stainless steel and have the pertinent ratings embossed in raised letters and numerals. The pertinent ratings shall include at least the following; amperage, voltage, phase, wires, AIC, manufacturer and model number.
- C. Phase and Neutral Buses: Tin-plated Hard-drawn copper, 98 percent conductivity.
- D. Equipment Ground Bus: Hard-drawn copper, adequate connections for feeder and branch-circuit equipment ground conductors; bonded to box.
- E. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- F. Main Device: Main lugs (MLO) or main circuit breaker (MCB), as indicated on the drawings.
- G. Conductor Connectors: Suitable for use with conductor material.
 - 1. Main and Neutral Lugs: Mechanical type.
 - 2. Ground Lugs and Bus Configured Terminators: Mechanical type.
 - 3. Feed-Through Lugs (where shown): Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- H. Circuit Breaker: Molded case, bolt-on type.
- I. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS

- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

- B. Main Device: Main lugs (MLO) or main circuit breaker (MCB), as indicated on the drawings.
- C. Branch Overcurrent Protective Devices:
 - 1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 - 2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 LOAD CENTERS

- A. Overcurrent Protective Devices: Plug-in, full-module circuit breaker.
- B. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.7 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response. Provide only where indicated on the drawings.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - 2. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.8 TOUCH-UP PAINT

- A. Furnish 0.5 pints of spare touch-up paint for each panelboard provided.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 74 inches above finished floor, unless otherwise indicated.
- C. Mount plumb and rigid without distortion of box.
- D. Install overcurrent protective devices and controllers.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems".
- B. Create a directory to indicate installed circuit loads. Indicate panelboard name, and the name of the upstream panelboard that feeds this panelboard with the words "Fed From Panel ____." Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Provide a copy of each directory, 1 per page, as part of the Operation and Maintenance Manual.
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems".
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cable".

3.4 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.

- B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
 - 1. Perform electrical test and visual and mechanical inspections described in the following NETA Acceptance Testing Specification Inspection and Test Procedures that are applicable to the products furnished for this project:
 - a. 7.1 “Switchgear and Switchboard Assemblies”
 - b. 7.6.1.1 “Circuit Breakers, Air, Insulated-Case, Molded-Case”
 - c. 7.19.1 “Surge Arresters, Low-Voltage”
 - 2. Certify compliance with test parameters.
 - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 FOLLOWUP SERVICE

- A. Infrared Scanning: One month after Substantial Completion, perform an infrared scanning of each panelboard in conformance with NETA Acceptance Testing Specification 9. “Thermographic Survey”. Remove panel fronts so joints and connections are accessible to portable scanner.
- B. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- C. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action. Provide a color photo along side an infrared photo of each panelboard in the report..

END OF SECTION

SECTION 26 24 19

MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide motor control centers as shown on the Drawings and specified herein.
- B. This Section includes motor control centers for use on ac circuits rated 600 V and less.

1.2 RELATED DOCUMENTS

- A. Related requirements are also included in the following Division 26 Sections:
 - 1. Motors are included in Division "Equipment", "Conveying Equipment", "Fire Protection", "Plumbing", and Heating Ventilation and Air Conditioning (HVAC) Section "Common Motor Requirements...".
 - 2. Variable Frequency Motor Controllers" for VFC's mounted in motor control centers.
 - 3. "Electrical Power Monitoring" for interfacing, communication, and metering requirements.
 - 4. "Electrical Controls and Relays" for pushbuttons, indicator lights, selector switches, and control stations.

1.3 DEFINITIONS

- A. In addition to the definitions in Division 26 Section "Electrical - General", the following definitions apply to this Section:
 - 1. DIP: dual-in-line pin or package
 - 2. MCC: motor control center

1.4 QUALIFICATIONS

- A. The motor control center structure, busbars, circuit breakers, and motor controllers shall be the products of a single manufacturer and shall be designed, tested, and manufactured in accordance with the standards referenced in this Specification.
- B. The motor control center manufacturer shall have quality certification to ISO 9000:2000, or an equivalent quality management system acceptable to the Engineer.

1.5 REFERENCE STANDARD

- A. Comply with the following standards in affect at the time of bid submittal:
 - 1. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
 - 2. National Electrical Code
 - 3. NEMA 250 Enclosures for Electrical Equipment
 - 4. NEMA ICS 2 - General Standards for Industrial Control Systems
 - 5. NEMA ICS 3 - Standards for Industrial Control Devices, Controllers and Assemblies
 - 6. NEMA ICS 18 – Motor Control Centers

7. NFPA 79 - Electrical Standard for Industrial Machinery
8. UL 508 - Industrial Control Equipment
9. UL 845 - Motor Control Centers

1.6 ENVIRONMENTAL CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 1. Temperature range, humidity range, and elevation as specified in Division 26 Section "Electrical - General".

1.7 SUBMITTALS

- A. Shop drawings: For each motor control center, submit specially prepared shop drawings including the following:
 1. Equipment nameplate data and electrical ratings
 2. Weights and overall dimensions
 3. General arrangement, section view, and sub-assembly drawings cross-indexed to a complete bill of materials listing all components and part numbers
 4. Three-line power schematic diagrams with control, protection and metering connection diagrams, and details.
 5. Plans, elevations, sections, and details showing installation dimensions, required clearances for access, operation and maintenance, installation details, and special instructions.
 6. Include product data sheets with the shop drawings.
- B. Product data sheets: showing manufacturer's standard products, and marked to show equipment selected for this project.
- C. Manufacturer's Installation Instructions: including manufacturer's shipping, receiving, handling, rigging, storage and setting instructions, recommendations, cautions, and warnings. Foundation details showing leveling channel, concrete, and anchor bolt details.
- D. Qualification Data: for testing firm
- E. Factory test reports.
- F. Acceptance test reports.
- G. Operation and Maintenance Data: For motor control centers, all installed devices, and components to include in emergency, operation, and maintenance manuals. Include the following:
 1. Routine maintenance requirements for motor control centers and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.8 QUALITY ASSURANCE

- A. Quality Certification: The switchgear manufacturer shall have quality certification to ISO 9000:2000 or an equivalent Quality Management System acceptable to the Engineer. Evidence of certification shall be submitted with equipment shop drawings.
- B. Manufacturer's repair service. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Source Limitations: Obtain motor control centers and controllers of a single type through one source from a single manufacturer.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NFPA 70.

1.9 EXISTING CONDITIONS

- A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving motor control centers into place.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Owner's Representative not less than 15 days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
 - 2. Indicate method of providing temporary utilities.
 - 3. Do not proceed with utility interruptions without Owner's written permission.

1.10 COORDINATION

- A. Coordinate layout and installation of motor control centers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division "Concrete".

- C. Coordinate features of motor control centers, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- D. Coordinate features, accessories, and functions of each motor control center, each controller, and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with the requirements in this Section, provide motor control centers by one of the following manufacturers:
 - 1. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group
 - 2. Eaton Corporation; Cutler-Hammer Products
 - 3. General Electric Company; GE Industrial Systems
 - 4. Groupe Schneider / Square D
 - 5. Or approved equal

2.2 GENERAL

- A. Motor control centers shall be suitable for the voltage, phase, and frequency shown on the Drawings.
- B. Motor controller sizes and ratings shown on the Drawings are estimated sizes based on typical manufactured products. Each motor controller size and ratings for this Project shall be suitable for the approved motor application (constant speed, reversing, two-speed single winding, two-speed two-winding, variable frequency) and motor nameplate full load current at rated voltage.
- C. Variable frequency controllers shall be suitable for the actual speed range (turndown ratio) required by the mechanical equipment application.
- D. Motor control centers shall be modular arrangements of incoming supply unit, combination motor starter and feeder units, control devices, transformers, panelboards, instruments, panels, and other items mounted in individual compartments of vertical motor control center sections.
- E. Circuit breakers and fused switches shall have stationary external operating handles, ON (closed) with the handle in UP position, OFF (open) with the handle in the DOWN position. Door-mounted operating handles and rotary switch and circuit breaker mechanisms are not acceptable.

2.3 CLASS, TYPE, AND RATINGS

- A. Wiring: NEMA ICS 3, Class II, Type B. Specially prepared control wiring diagrams showing each remote device connection are required for each motor controller.
 - 1. Equip units in Type B motor control centers with pull-apart control terminal strips or drawout terminal boards for external control connections.
- B. Enclosures: NEMA 250, Type as shown on the Drawings.

1. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners. Interlocks on units requiring disconnecting means to be open before door can be opened or closed, except by operating a permissive release device requiring a tool.
 2. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in motor control center; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
 3. Install combination starter units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 4. Individual feeder-tap units through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 5. Wireways: Separate vertical wiring channel in each vertical section for vertical wiring to each unit compartment; with supports to hold wiring in place. 12 inch bottom wireway and 6 inch top wireway for outgoing wiring.
- C. Short-Circuit Current Rating for Each Section: Fully rated and NRTL-listed and labeled for the available fault current shown on the Drawings.

2.4 BUSBARS

- A. Material: Hard-drawn copper, tin-plated full length of main and plug-in busbars.
- B. Continuous Current Ratings: As shown on the Drawings for horizontal and vertical main buses. Vertical plug-in busbars shall be minimum 300 amps.
- C. Neutral Buses: Full size.
- D. Equipment Ground Busbars: Bare $\frac{1}{4}$ x 2 inch copper main (horizontal) ground busbar bolted to enclosure. Vertical ground busbars shall be same materials of construction as vertical phase plug-in busbars, sized per NEC minimum requirements for equipment grounding conductors; bond to enclosure and each plug-in compartment.
- E. Horizontal Busbar Arrangement: Main and ground busbars extended with same capacity the entire length of motor control center, with provision for future extension at both ends by bolt holes and captive busbar splice sections or equivalent.
- F. Short-Circuit Withstand Rating: Same as short-circuit current rating of vertical section.

2.5 INCOMING SUPPLY UNITS

- A. Incoming supply: Fused switch suitable for bottom feed as follows:
- B. Main Lugs Only: Main busbars drilled for two-hole compression type wire connectors. Compartment door marked "Incoming Supply".

- C. Fusible Switch: NEMA KS 1, Type HD, clips to accommodate specified fuses with lockable handle.
- D. Transient Voltage Surge Suppressors: Connect to motor control center bus after the incoming supply main overcurrent protection device.
- E. Short Circuit Rating: fully rated for the available fault current shown on the Drawings.

2.6 FEEDER UNITS

- A. Feeder Units: Fused switches.
- B. Fusible Switch: NEMA KS 1, Type HD, clips to accommodate specified fuses with lockable handle.
- C. Short Circuit Rating: fully rated for the available fault current shown on the Drawings.

2.7 COMBINATION MOTOR STARTER UNITS

- A. Combination Motor Starters: Combination disconnecting means and motor starters as specified in this Section and shown on the Drawings.
 - 1. Controller Disconnecting Means and Overcurrent Protection:
 - a. Fusible Disconnect Switch: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips. Select and size fuses to provide NRTL-listed Type 2 protection according to IEC 947-4-1.
 - 2. Magnetic starter:
 - a. Contactor: NEMA ICS 2, Class A, with continuous current rating as specified in NEMA standards, size 1 minimum. Full voltage non-reversing or full voltage reversing as shown on Drawings. Contactors for reversing starters shall be mechanically interlocked.
 - b. Overload Relay: Ambient-compensated type with inverse-time-current characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
 - 3. Control Devices: As shown on the Drawings and in accordance with the Division 26 Section "Electrical Controls and Relays".
 - 4. Auxiliary contacts as required for the control scheme, plus 1 N.O. and 1 N.C. spares.
 - 5. Control Wiring:
 - a. Provide control wiring as shown on the Drawings.
 - 6. Short Circuit Rating: fully rated for the available fault current shown on the Drawings.

2.8 SPARE UNITS

- A. Spare Units: Type, sizes, and ratings as shown on the Drawings.
- B. Short Circuit Rating: fully rated for the available fault current shown on the Drawings.

2.9 SPACES

- A. Spaces: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.

2.10 VARIABLE FREQUENCY CONTROLLERS

- A. Variable frequency controllers shall be in conformance with Division 26 Section "Variable Frequency Motor Controllers", and shall be incorporated into the MCC lineup as shown on the Drawings.

2.11 CONTROL DEVICES

- A. Control devices shall be factory-installed and factory-wired in controller enclosure.
- B. Conform to NFPA 79 Electrical Standard for Industrial Machinery.
- C. Control devices, including relays, pushbuttons, pilot lights, selector switches, and elapsed time meters, shall conform to Division 26 Section "Electrical Controls and Relays".

2.12 METERING

- A. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 - 2. Switch-selectable digital display of the following:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Three-Phase Real Power: Plus or minus 2 percent.
 - e. Three-Phase Reactive Power: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Integrated Demand with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - 3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.13 FACTORY FINISHES

- A. Finish: Manufacturer's standard ANSI 61 light gray paint applied to factory-assembled and -tested, motor control centers before shipping.

2.14 QUALITY ASSURANCE

- A. Factory Quality Certification
 - 1. Submit copy of factory quality assurance certificate.
- B. Factory Assembly

1. Motor control centers shall be manufactured in conformance with the factory quality certification documents.

C. Factory Tests

1. Each MCC shall be factory tested as follows:
 - a. Manufacturer's standard inspections and tests
 - b. 1000V megohmmeter test on each busbar, phase-to-phase and phase-to-ground, after disconnecting devices sensitive to 500 VDC.
2. Submit factory test report for approval prior to shipment.

2.15 SPARE PARTS AND SPECIAL TOOLS

- A. Spare-Fuse Cabinet: Labeled cabinet with hinged lockable door for separate wall mounting.
- B. Provide minimum 10 spare fuses of each size and type furnished for each MCC.
- C. Furnish one pint of spare touchup paint for each MCC provided.

2.16 PACKAGING FOR SHIPMENT

- A. Wrap motor control centers with dessicant in heavy polyethylene film taped shut.
- B. Bolt MCC shipping sections to wooden pallets to prevent tipping over and to provide method for transporting shipping sections.
- C. Shipping sections shall be padded and corner-protected to protect components from damage during shipping.

2.17 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Deliver motor control centers in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Handle motor control centers according to the following:
 1. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
 2. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."

3.2 PRE-INSTALLATION REQUIREMENTS

- A. Floor, wall, and ceiling finishes and overhead welding operations shall be substantially complete, and area shall be "broom clean", prior to commencing installation of the motor control centers.

3.3 INSTALLATION

- A. Anchor each motor control center assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with motor control center mounting surface.
- B. Install motor control centers on concrete bases in conformance with MCC manufacturer's installation instructions.

3.4 CONCRETE BASES

- A. Coordinate size and location of concrete bases with approved MCC shop drawings.
- B. Concrete materials and installation requirements shall be as specified in Division "Concrete".

3.5 IDENTIFICATION IN THE FIELD

- A. Identify motor control center, motor control center components, and control wiring according to Division 26 Section "Identification for Electrical Systems".

3.6 CONTROL WIRING INSTALLATION

- A. Install wiring for motor control devices as shown on the Drawings.
- B. Control wire, raceways, boxes, fittings and connections from remote devices to MCC's will be installed under Division 26 Section "Raceways and Boxes for Electrical Systems".
- C. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 GROUNDING AND BONDING

- A. Ground MCC equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems".

3.8 CLEANING

- A. On completion of installation, inspect interior and exterior of each motor control center. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.9 MANUFACTURER'S FIELD SERVICES

- A. Engage a factory-authorized service representative to perform the following inspections, checks, and supervision of testing:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with the manufacturer's installation recommendations and requirements.

2. Set field-adjustable, protective-relay trip characteristics to the values tabulated in the report specified in Division 26 Section "Overcurrent Protective Device Coordination Study".
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and components.
4. Supervise tests performed by independent testing firms. Witness initial energization and perform or supervise startup services.
5. Prepare written report to record the following:
 - a. Inspections and checks carried out on site.
 - b. Test procedures used.
 - c. Test results that comply with requirements.
 - d. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements

3.10 ACCEPTANCE TESTING

- A. Prepare for acceptance tests as follows:
 1. Test insulation resistance for each motor control center element, bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
 1. Perform each electrical test and visual and mechanical inspection described in the following NETA Acceptance Testing Specification Inspection and Test Procedures applicable to the equipment furnished for this project:
 2. 7.6.1.1 "Circuit Breakers, Air, Insulated-Case/Molded-Case"
 3. 7.10 "Instrument Transformers"
 4. 7.11 "Metering Devices"
 5. 7.13 "Grounding Systems"
 6. 7.14 "Ground-Fault Protection Systems, Low-Voltage"
 7. 7.16.2.1 "Motor Control, Motor Control Centers, Low-Voltage."
 8. 7.19.1 "Surge Arrestors, Low-Voltage"
 9. Certify compliance with test parameters.
 10. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.11 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain components of motor control centers.
- B. Review each page of the Operation and Maintenance Manuals during the training sessions.

3.12 FOLLOW-UP SERVICE

- A. Infrared Scanning: One month after Substantial Completion, perform an infrared scanning of each Motor Control Center in conformance with NETA Acceptance Testing Specification 9 "Thermographic Survey". Open motor control center doors so joints and connections are accessible to portable scanner.

- B. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor control center 11 months after date of Substantial Completion.
- C. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Record of Infrared Scanning: Prepare a certified report that identifies motor control center checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action. Provide a color photo along side an infrared photo of each motor control center in the report.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide switches, receptacles, and accessories required for a complete and fully functional installation, as shown on the Drawings and specified herein.

1.2 RELATED WORK

- A. Refer to Division 26 Section "Raceways and Boxes for Electrical Systems" for outlet box requirements.
- B. Refer to Division 26 Section "Identification for Electrical Systems" for receptacle circuit identification requirements.
- C. Refer to Division 26 Section "Low-Voltage Electrical Power Conductors and Cable" for wire requirements.

1.3 REFERENCES

- A. Material and installation shall be in accordance with latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standard Institute (ANSI)
 - 2. National Electrical Code (NEC)
 - 3. National Electrical Manufacturers Association (NEMA)
 - 4. Underwriters Laboratories, Inc. (UL)

1.4 QUALITY ASSURANCE

1.5 SUBMITTALS

- A. General
 - 1. Submittals and samples shall conform to the Division 26 Section "Electrical - General".
- B. Manufacturer's Catalog Data
 - 1. Submit manufacturer's catalog data describing the material and demonstrating conformance to the Specification, associated standards, and test requirements.
- C. Other Submittals
 - 1. Samples are not required for specified manufacturers and part numbers. If "equal" products are proposed, samples of both the "equal" and the specified product shall be submitted for comparison purposes.
- D. Equal products will not be considered unless samples are submitted.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide industrial grade heavy-duty wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL, Federal, and NEMA standards.
- B. Provide ivory color devices unless otherwise indicated.
- C. Model or series numbers, where indicated, refer only to the specified manufacturer. Identical numbers by other manufacturers are not considered equal.

2.2 SWITCHES AND RECEPTACLES

- A. Receptacles
 - 1. Wall plug receptacles shall be NEMA 5-15R rated 15 amperes at 120 VAC of the two-pole, three-wire type. They shall be suitable for use with a three-wire polarized plug having two parallel blades and shall have the third leg grounded. They shall meet the requirements of Federal Specification WC596.
 - 2. All duplex receptacles shall be:
 - a. Hubbell 5262 Series heavy-duty industrial grade.
 - b. Leviton 5262 Series heavy-duty industrial grade
 - c. Or approved equal (samples of any proposed equal products shall be submitted as noted above).
- B. GFI Receptacles
 - 1. Receptacles marked as GFI shall be of the ground fault interrupter type. They shall be UL rated Class A, Group 1, and shall be as follows:
 - a. Hubbell Series GF5262
 - b. Equal
 - 2. Single GFI Receptacles providing "downstream" protection are not acceptable.
 - 3. GFI breakers used with conventional receptacles shall not be acceptable where GFI receptacles are shown.
- C. Device Boxes for receptacles shall be of the type appropriate for each location as specified under Division 26 Section "Raceway and Boxes for Electrical Systems".
- D. Surface Metal Raceway
 - 1. Surface metal raceway shall be galvanized steel raceway 4 in. high x 3-9/16 in. deep. Raceway shall have removable cover and all couplings, device plates, hangers, connectors, and accessories required for a complete installation shall be provided. Finish shall be gray. Surface metal raceway shall be:
 - a. Wiremold G-6000
 - 1) Or approved equal.
 - 2. Wiring devices shall be as specified in this Section.

E. Switches

1. Light switches shall be rated 20 amperes at 277 VAC, toggle operated, plastic enclosed, single pole, three-way or four-way as shown or required. They shall meet Federal Specification WS896.
 - a. Hubbell 1221 Series heavy-duty industrial grade
 - b. Leviton 1221 Series heavy-duty industrial grade
 - c. Arrow Hart 1221 Series heavy-duty industrial grade
 - d. Equal (samples of any proposed equal products shall be submitted as noted above)
2. Switches shall have silver alloy contacts and provisions for side and back wiring.
3. Device boxes for switches shall be of the type appropriate for each location as specified under Division 26 Section "Raceways and Boxes for Electrical Systems".

F. Corrosion Resistant Devices

1. Devices used in areas designated as "corrosive" and "wet" shall be constructed of corrosion resistant materials.
2. Devices shall be industrial grade heavy-duty constructed with additional protection from corrosive environments including additional nickel plating on metallic parts, melamine bodies, and weatherproof boots.
3. Devices shall be as follows:
 - a. Hubbell Series CM
 - b. Leviton Series CM
 - c. Arrow Hart Series CR
 - d. Or approved equal.
 - e. Samples of any proposed equal products shall be submitted as noted above.

G. Cover Plates

1. Cover plates shall conform to NEC requirements and local electrical code requirements.
2. Cover plates for flush-mounted devices shall be brushed stainless steel, type 304 grade or better, with stainless steel screws. Plates shall be as follows:
 - a. Hubbell S Series
 - b. Leviton S Series
 - c. Arrow Hart S1 Series
 - d. Or approved equal
3. Cover plates in unfinished areas shall match the box materials and finish.
4. Cover plates in wet and outdoor areas shall be of corrosion-resistant weatherproof design, and shall conform to NEC requirements for "weatherproof when in use" and "weatherproof when not in use".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wiring devices in outlet boxes with cubic inch capacity in conformance with NEC requirements.

- B. Wall receptacles shall be mounted at 18 inches to the centerline of the device box above finished floor, unless otherwise indicated.
- C. Light switches shall be mounted 44 inches to the centerline of device box above finished floor on strike side of doors unless otherwise indicated.
- D. Install green grounding screw with NEC-sized copper grounding pigtail in tapped hole in each outlet box. Bond wiring device strap to pigtail.
- E. Coordinate switch and receptacle locations and construction sequence with the work of other trades, including base cabinets, wall cabinets, kitchenettes, thermostats, fire alarm devices, door frames, window frames, and other devices that are required to be mounted in the same area, to avoid conflicts.
- F. Install outlet boxes, wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, and applicable requirements of the NEC.
- G. Protect installed outlet boxes from dirt, drywall joint compound, and paint.
- H. Install wiring devices after wiring and plastering work is completed.
- I. Protect installed wiring devices from plaster and paint.
- J. Install cover plates after painting work is completed.
- K. Label receptacles as described in Division 26 Section "Identification for Electrical Systems".

3.2 TESTING

- A. Test installed, energized receptacles and switches for correct connection to phase, neutral, and ground wires.
- B. Correct incorrectly wired switches and receptacles.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide enclosed AC switches and circuit breakers rated 600 V and less, of the following types:
 - 1. Non-Fused Disconnect Switches
 - 2. Fused Disconnect Switches
 - 3. Automatic Transfer Switches
 - 4. Enclosed Circuit Breakers

1.2 RELATED DOCUMENTS

- A. Related Documents include the following Division 26 Sections:
 - 1. "Variable Frequency Motor Controllers" for variable frequency controller requirements.
 - 2. "Electrical Controls and Relays" for relays, pushbuttons, indicator lights, selector switches, elapsed time meters, terminal blocks, and control stations.

1.3 SUBMITTALS

- A. Submittals shall conform to the General Conditions.
- B. Product Data: For each type of enclosed switch. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, UL listing, and finishes.
- C. Shop Drawings: For each automatic transfer switch.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit withstand current rating.
 - d. UL listing.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- D. Qualification Data: For testing agency.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Routine maintenance requirements for enclosed switches and circuit breakers and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain enclosed switches and circuit breakers of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed switches and circuit breakers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed switches and circuit breakers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed switches and circuit breakers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switches and circuit breakers; install electric heating of sufficient wattage to prevent condensation.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify Owner no fewer than five days in advance of proposed interruption of electrical service.
 2. Indicate method of providing temporary utilities.
 3. Do not proceed with interruption of electrical service without [Engineer's] [Construction Manager's] [Owner's] written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of enclosed switches and circuit breakers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 SPARE PARTS

- A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Enclosure types shall be as specified in Division 26 Section "Electrical - General".
- B. Enclosed switches and circuit breakers shall be UL listed.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
 - 2. Eaton Corporation; Cutler-Hammer Products.
 - 3. General Electrical Company; GE Industrial Systems.
 - 4. Siemens.
 - 5. Square D.

2.3 NON-FUSED DISCONNECT SWITCHES

- A. Non-fused disconnect switches shall be heavy-duty, 3-pole, 600 volt, motor-rated, visible blade type, with cover interlock to prevent opening the door with the switch closed.
- B. Provide external operating handle with padlocking provisions. Switch shall be closed when the handle is in the UP position, and open in the DOWN position. Rotary handles are not acceptable.
- C. Provide insulated neutral bus when neutral wire is shown on the Drawings.
- D. Provide copper ground bus for equipment grounding conductors.

- E. Where indicated on the Drawings, provide auxiliary interlock contacts that open the motor control circuit before opening the motor branch circuit.
- F. Non-fused disconnect switches shall be similar and equal to Square D Class 3110 Heavy Duty Safety Switches.

2.4 FUSED DISCONNECT SWITCHES

- A. Fused disconnect switches shall be equal to the non-fused disconnect switches described above, except that fuse clips and fuses shall be provided as indicated on the Drawings.
- B. Fused disconnects used as service entrance equipment shall be U.L. listed and labeled "Suitable for Use as Service Entrance Equipment".

2.5 ENCLOSED CIRCUIT BREAKERS

- A. Enclosed circuit breakers shall be molded-case thermal-magnetic type, with trip and frame ratings as shown on the Drawings, with cover interlock to prevent opening the door with the circuit breaker closed.
- B. Provide external operating handle with padlocking provisions. Circuit breaker shall be closed when the handle is in the UP position, and open in the DOWN position. Rotary handles are not acceptable.
- C. Circuit breakers shall be fully rated for the available fault current. Series ratings are not acceptable.
- D. Provide insulated neutral bus when neutral conductor is shown on the Drawings.
- E. Provide copper ground bus for equipment grounding conductors.
- F. Enclosed circuit breakers shall be similar and equal to Square D Class 610.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. For wall-mounted enclosures, bolt units to channels bolted to wall. For wall-mounted enclosures not near walls, provide freestanding racks constructed from 1-1/2 x 1-1/2 inch channels.
- B. Install freestanding equipment on concrete bases.

3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases with approved equipment dimensions.

3.3 IDENTIFICATION

- A. Identify enclosed circuit breakers, components, and control wiring in conformance with Division 26 Section "Identification for Electrical Systems".

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect switches and circuit breakers, wiring, components, connections, and equipment installation. Test and adjust switches and circuit breakers, components, and equipment.
 - 2. Assist in field testing of equipment including pre-testing and adjusting of switches and circuit breakers.
 - 3. Report results in writing.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- D. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in the following NETA Acceptance Testing Specification Inspection and Test Procedures:
 - a. 7.5.1.1 "Switches, Air, Low-Voltage"
 - b. 7.6.1.1 "Circuit Breakers, Air, Insulated-Case, Molded-Case".
 - c. 7.22.3 "Emergency Systems, Automatic Transfer Switches".
 - 2. Certify compliance with test parameters.
 - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed switches and circuit breakers.

* * * * *

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide enclosed AC motor controllers as shown on the Drawings and as specified herein.
- B. Enclosed controllers shall be of the following types:
 - 1. Manual motor starting switches.
- C. Enclosed motor controllers shall be suitable for the motor application and motor nameplate HP, voltage, and full load current.

1.2 RELATED DOCUMENTS

- A. Related Division 26 Sections include:
 - 1. "Variable Frequency Motor Controllers" for variable frequency controller requirements.
 - 2. "Electrical Controls and Relays" for relays, pushbuttons, indicator lights, selector switches, elapsed time meters, terminal blocks, and control stations.

1.3 SUBMITTALS

- A. Submittals shall conform to the General Conditions.
- B. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- C. Shop Drawings: For each enclosed controller.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- D. Qualification Data: For testing agency.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Routine maintenance requirements for enclosed controllers and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify Owner no fewer than five days in advance of proposed interruption of electrical service.
 2. Indicate method of providing temporary utilities.
 3. Do not proceed with interruption of electrical service without Owner's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 SPARE PARTS

- A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
 - 2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Enclosure types shall be as specified in Division 26 Section "Electrical - General".

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
 - 2. Eaton Corporation; Cutler-Hammer Products.
 - 3. General Electrical Company; GE Industrial Systems.
 - 4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
 - 5. Square D.
 - 6. Or approved equal

2.3 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Single Phase Manual Motor Starter: NEMA ICS 2, Class A, general purpose, 1 or 2-pole with single speed, non-reversing with toggle handle , red pilot light, and overload relay. Toggle handle shall have feature to allow padlocking in the off position.

2.4 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select motor controllers to suit the motor horsepower and full load current rating, and application.

3.3 INSTALLATION

- A. For wall-mounted enclosures, bolt units to channels bolted to wall. For wall-mounted enclosures not near walls, provide freestanding racks constructed from 1-1/2 x 1-1/2 inch channels.
- B. Controllers shall be mounted 44 inches to the centerline of the device above finished floor.

3.4 IDENTIFICATION

- A. Identify enclosed controller, components, and control wiring in conformance with Division 26 Section "Identification for Electrical Systems".

3.5 CONTROL WIRING INSTALLATION

- A. Provide motor control wiring as shown on the Drawings.
- B. Install wiring as shown on the Drawings.
- C. Bundle, train, and support wiring in enclosures.
- D. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems".

3.7 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in the following NETA Acceptance Testing Specification Inspection and Test Procedures:
 - 2. 7.16.1.1 "Motor Control, Motor Starters, Low-Voltage"
 - 3. Certify compliance with test parameters.
 - 4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide Variable Frequency Drives (VFDs) in compliance with this Section for motors that drive mechanical equipment specified in other Divisions of the Specification.
- B. Obtain approval for a preliminary harmonics analysis report for the proposed VFDs prior to submittal of shop drawings, and for a final harmonics analysis report with the VFD manufacturer's shop drawings.
- C. This Section describes requirements for variable frequency motor controllers for variable speed control of inverter-duty induction motors described in Division 26 Section "Common Motor Requirements".

1.2 RELATED DOCUMENTS

- A. Motors are included in Division 26 Section "Common Motor Requirements".
- B. Control system and control and signal wiring is specified in Division "Heating Ventilating and Air Conditioning (HVAC)".

1.3 QUALIFICATIONS

- A. The variable frequency drive shall be designed, assembled, factory-tested, setup and commissioned by the AC converter – DC link – variable frequency AC inverter manufacturer.

1.4 DEFINITIONS

- A. In addition to the definitions in Division 26 Section "Electrical - General", the following definitions apply to this Section:
 - 1. AC: Alternating Current
 - 2. BMS: Building Management Systems
 - 3. Converter: Converts AC to DC
 - 4. DC: Direct Current
 - 5. HP: Horsepower
 - 6. I/O: Input / Output
 - 7. IGBT: Insulated gate bipolar transistor.
 - 8. Inverter: Converts DC to AC
 - 9. PWM: Pulse-Width Modulated.
 - 10. Point of Analysis: with reference to IEEE 519, the point of common coupling selected by the Engineer
 - 11. TDD: Total Demand Distortion as defined in IEEE 519
 - 12. THD: Total Harmonic Distortion as defined in IEEE 519

1.5 REFERENCE STANDARDS

A. Comply with the following standards:

1. IEEE 519 IEEE Recommended Practices & Requirements for Harmonic Controls in Electrical Power Systems
2. NEMA FU 1 Low Voltage Cartridge Fuses
3. NEMA ICS 6 Industrial Control and Systems Enclosures
4. NEMA KS 1 Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
5. NEMA MG 1 Motors and Generators
6. NEMA MG 10 Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
7. NFPA 70 National Electrical Code
8. NFPA 79 Electrical Standard for Industrial Machinery
9. UL 198C High-Interrupting-Capacity Fuses, Current-Limiting Types
10. UL 50 Safety Enclosures for Electrical Equipment
11. UL 508 Industrial Control Equipment

1.6 SUBMITTALS

A. Preconstruction Submittals

1. Qualifications data for Testing Firm and Testing Firm's Field Supervisor.
2. Qualification data for Manufacturer, including Quality Certification.
3. Preliminary Harmonic Analysis

B. Shop Drawings

1. Compliance Statement
2. Specially prepared shop drawings including the following:
 - a. Equipment nameplate data and electrical ratings
 - b. Weights and overall dimensions
 - c. General arrangement, plan view, section view, elevation and sub-assembly drawings cross-indexed to a complete bill of materials listing all components and part numbers. Include layout of door-mounted components. Show conduit entry areas and field wiring termination points.
 - d. Three-line AC power schematic diagrams.
 - e. Control schematic showing all control devices.
 - f. Field wiring diagram showing each external device connected.
 - g. Installation instruction including details, required clearances for access, operation and maintenance, and special instructions for unloading and hoisting, short term and long term storage, and unpacking.
3. Final Harmonic Analysis

C. Product Data Sheets

1. Technical data sheets for manufactured equipment and sub-assemblies, marked to show equipment selected for this project. Include product data sheets in Shop Drawing submittal.

D. Test Reports

1. Factory test reports
2. Acceptance test reports

- E. Drawings and Details
 - 1. Dimensioned Outline Drawings of Equipment: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. Manufacturer's Instructions
 - 1. Shipping, receiving, handling, rigging, storage and setting instructions, recommendations, cautions, and warnings. Foundation details showing leveling channel, concrete, and anchor bolt details.
- G. Manufacturer's Field Reports
 - 1. Inspection of equipment installation (prior to energization and startup) report
 - 2. Complete tabulation of equipment settings and adjustments, and functional testing report
 - 3. Training report
- H. Operation and Maintenance Data
 - 1. Operation and Maintenance Instructions: For equipment and accessories, including pre-energization tests and checks, initial startup procedure, manufacturer's written instructions for testing and adjusting overcurrent protective devices, exploded views of major assemblies and sub-assemblies indexed to parts lists, maintenance instructions and recommended maintenance intervals, troubleshooting procedures, and contact details for spare parts purchase and technical support.
 - 2. Training course materials
- I. Closeout Submittals
 - 1. Follow up service reports
 - 2. Warranty
- J. Additional requirements are specified in Division 26 Section "Electrical - General".

1.7 QUALITY ASSURANCE

- A. All VFDs for this project shall be supplied by the same manufacturer.
- B. VFD sizing shall be based on the nameplate data for the motor selected by the mechanical equipment supplier to operate at variable frequency over the specified speed range.
- C. Quality Certification: The variable frequency drive motor controllers manufacturer shall have quality certification to ISO 9000:2000. Evidence of certification shall be submitted with equipment shop drawings.
- D. Total Harmonic Distortion Limits: The VFD Supplier shall use these values for calculation of total demand distortion in accordance with IEEE 519 Table 10.3 Harmonic Current Distortion Limits for 5% TDD at the Point of Analysis:
 - 1. Minimum available fault current shall be the Coordination Study 3 phase fault current, without the motor contribution, at the Point of Analysis.

2. Maximum demand load current (including VFDs) = ____ amperes RMS at 60 Hz.
 3. Electrical Service Transformer: kVA, %Z, X/R ratio shall be obtained from the serving utility.
 4. Linear load shall be the maximum demand load current calculated above, less any VFD loads.
 5. The VFDs shall operate on the electrical power distribution system shown on the Drawings without exceeding 3% of the fundamental and 5% of the total harmonic voltage distortion at the Point of Analysis in accordance with IEEE 519-10.
- E. Technical Support: The manufacturer shall maintain a service center capable of providing training, parts, and emergency maintenance and repairs within 200 miles of Project site.
- F. VFDs shall be shipped to the project site as fully assembled, wired and factory tested.

1.8 PROJECT CONDITIONS

- A. Ambient temperature, humidity, and elevation: Equipment shall be rated for continuous operation, capable of driving full load without derating, within the ambient temperature, humidity, and elevation ranges specified in Division 26 Section "Electrical - General".
- B. Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify the Owner a minimum of 1 week in advance of proposed interruption of electrical service.
 2. Submit step-by-step plan for proposed method of providing temporary electrical service to the Owner for acceptance.
 3. Do not proceed with interruption of electrical service without written permission from the Owner.
- C. Product Selection for Restricted Space: Drawings show allowable space to scale for anticipated VFD sizes. Comply with NEC requirements for working clearances and with manufacturer's recommendations for access for maintenance. Notify the Engineer if insufficient space is available for available products.

1.9 COORDINATION

- A. The Contractor is required to coordinate selection of variable frequency controller and motor to match equipment provided under other Sections in order to meet the Specification requirements for a complete and fully functional system.
- B. Coordination Drawings: layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- C. For freestanding enclosures, coordinate size and location of concrete equipment pads with the work of other trades in the area. Use afterset epoxy anchors to anchor equipment to concrete pads unless otherwise instructed by the equipment manufacturer. Concrete,

reinforcement, and formwork requirements are specified in Division "Concrete" Section "Cast-in-Place Concrete".

- D. Coordinate output current and motor full load current ratings with equipment provided under other Sections of the Specification.
- E. Provide VFD-to-motor wire size and length data to the VFD manufacturer prior to shop drawing submittal so that the VFD manufacturer can include accessory devices, such as output line reactors and motor termination DV/DT reduction devices that may be necessary to limit the impulse voltage at the motor to values within the inverter-duty motor insulation impulse voltage rating specified in Division 26 Section "Common Motor Requirements".
- F. Coordinate controller interfaces with pilot devices and control and signal circuits. Follow the VFD manufacturer's recommendations for power, control, and signal cable separation and related installation details.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND COMPONENTS

- A. Variable frequency drives for motors shall be 6-pulse.
- B. Materials, equipment, and devices shall be NRTL-listed, and shall comply with NFPA 70 National Electrical Code requirements.
- C. Variable frequency drives shall be NEMA 4X rated.

2.2 MANUFACTURERS

- A. Available 6 pulse variable frequency motor controller manufacturers: Subject to compliance with harmonic distortion limits, manufacturers include the following:
 - 1. Rockwell Automation Inc. / Allen Bradley
 - 2. Eaton Corporation / Cutler Hammer
 - 3. Or approved equal

2.3 GENERAL DESCRIPTION

- A. Solid-state VFD and accessories with full-wave diode bridge AC-to-DC converter, and PWM-type IGBT output, integrated into enclosures with other devices as shown on the Drawings. Accessories as specified herein, listed and labeled as a complete unit. Provide variable speed control of a NEMA Design B, 3-phase squirrel-cage induction motor by adjusting output voltage and frequency while maintaining a constant volts/hertz ratio.
- B. VFD's are 6 pulse type (number of pulses during a single cycle of the three phase voltage), with or without harmonic filters, as necessary to meet the specified harmonic distortion limits.
- C. VFD circuit boards shall all have conformal coating, no exceptions.

2.4 DRIVE PERFORMANCE REQUIREMENTS

- A. The VFD shall control the motor speed over the range of 25 percent to 100 percent of base speed without motor forced-cooling accessories.
- B. Provide VFD output line voltage conditioning devices such as output reactors, output filters, and motor termination filters, to reduce impulse voltage at the motor terminals to values acceptable for operation of inverter-duty motors having approximately 1600 volt 1 microsecond impulse voltage withstand rating as defined by NEMA MG 1.
- C. The VFD's for the following motors: PEPS Pump No.1, PEPS Pump No.2 and PEPS Pump No.3 will require a bypass contactor. Each VFD for the above referenced pumps shall be provided with an over-sized enclosure that will house a 6-pole switch with an isolation barrier. When the switch is engaged, the line and load side of the VFD is opened and the line and load side are closed on the contactor. The switch shall be keyed to prevent any unauthorized use.

2.5 CONTROLLER PERFORMANCE REQUIREMENTS:

- A. Controllers shall be designed for operation with the following performance:
 - 1. Minimum Efficiency: 95 percent at 60 Hz, full load.
 - 2. Minimum Displacement Power Factor: 95 percent.
 - 3. Constant Torque Controller Overload Capability: 150% of continuous current output for 60 seconds.
 - 4. Variable Torque Controller Overload Capability: 110% of continuous current output for 60 seconds; 150% of continuous current output for 3 seconds.
 - 5. Starting Torque: provide starting boost up to 150%
 - 6. Speed Regulation: Plus or minus 1 percent without tachometer feedback.
- B. Controllers shall be equipped with the following internal adjustable functions:
 - 1. Minimum Speed: 5 to 25 percent of maximum rpm.
 - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3. Acceleration Ramp: 2 to 22 seconds.
 - 4. Deceleration Ramp: 2 to 22 seconds.
 - 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
 - 6. Slip Compensation: adjustable
 - 7. Skip frequency bands: minimum of three to avoid mechanical equipment critical frequencies
 - 8. Carrier frequency: adjustable
- C. Controllers shall have the following self-protection and reliability features:
 - 1. Under- and over-voltage trips; inverter over-temperature, overload, and over-current trips.
 - 2. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 10 performance for submersible pump motors and Class 20 performance for standard NEMA frame motors.
 - 3. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 - 4. Instantaneous line-to-line and line-to-ground over-current trips.
 - 5. Loss-of-phase protection.

6. Short-circuit protection.
7. Motor over-temperature fault (for motors specified with over-temperature protection).
8. Historical Logging Information and Displays:
 - a. Real-time clock with current time and date.
 - b. Running log of total power versus time.
 - c. Total run time.
 - d. Fault log, maintaining last four faults with time and date stamp for each.
9. Operate at temperatures range of 5 deg. F. to 23 deg. F.

2.6 CONTROLLER ACCESSORIES

- A. Provide the following accessories:
 1. Integral disconnect: molded case thermal-magnetic circuit breaker with external flange-mounted operating handle, padlockable in the OFF position. Circuit breaker shall be fully rated for the available fault current at the variable frequency controller.
 2. Current limiting fuses at the input to the inverter. Fuses shall be specifically designed for applications requiring protection of solid-state electronic power components.
 3. Harmonic Filter: Provide where required. Filter shall consist of a 5% impedance input reactor and passive filter tuned to the fifth harmonic. Capacitors shall be individually fused, Filter shall have a contactor controlled by a voltage free contact input to disconnect capacitors when motor is off. Filter controls shall operate at 120 VAC and shall be powered from control power transformers located in the VFD enclosures.
 4. VFD Output Filtering: Provide where required. Output line reactors and filtering devices (at motors) for limiting voltage at motor terminal at VFD carrier frequencies to less than the motor impulse voltage rating.
 5. Control devices: Provide control devices as shown on the Drawings, as recommended by the manufacturer and as necessary for a complete operation. Pushbuttons, selector switches and indicating lights shall be mounted on the enclosure door. Devices shall be in accordance with the Division 26 Section "Electrical Controls and Relays".

2.7 SPECIAL APPLICATIONS

- A. Catch a Spinning Load: Bi-directional automatic speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- B. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.

2.8 FRONT-OF-ENCLOSURE MOUNTED DEVICES:

- A. Provide the following devices mounted on the door of the controller enclosure:
 1. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
 - a. Power On (White)

- b. Motor Running (Green)
- c. Fault (Amber)
- 2. Operator Control Station:
 - a. LOCAL-OFF-REMOTE selector switch for start-stop commands
 - b. LOCAL-REMOTE selector switch for speed reference signals
 - c. Green START and red STOP pushbuttons
 - d. Red RUNNING and green STOPPED indicator lights
 - e. Black RESET pushbutton with shroud for variable frequency fault reset.
 - f. Black mechanical RESET pushbutton for motor overload relay.
 - g. Local keypad RAISE – LOWER speed control.
- 3. Indicating Devices: Keypad to indicate the following controller parameters:
 - a. Output frequency (Hz).
 - b. Motor speed (rpm).
 - c. Motor status (running, stop, fault).
 - d. Motor current (amperes).
 - e. Motor torque (percent).
 - f. Fault or alarm status (code).
 - g. Speed feedback signal (percent).
 - h. DC-link voltage (VDC).
 - i. Set-point frequency (Hz).
 - j. Output voltage (V).

2.9 CONTROLS INTERFACE:

- A. Remote START and STOP commands shall be dry ("volts-free") contacts that close to start the VFD and open to stop it.
- B. Remote Signal Inputs: Accept a 4-20 milliamp DC speed input command.
- C. Output Signal Interface:
 - 1. A minimum of one isolated analog output signal (4-20 milliamp DC), which can be programmed to any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. Motor torque (percent).
 - d. Motor speed (rpm).
 - e. Set-point frequency (Hz).
- D. Remote Status and Alarm Indication Interface: A minimum of one Form C 10 amp 120 V AC dry circuit relay outputs for remote indication of each of the following:
 - 1. RUNNING status (forward and reverse)
 - 2. controller READY (controller LOCAL-OFF-REMOTE selector switch is in REMOTE, and control power is on, and controller is available for normal operation)
 - 3. SHUTDOWN on fault condition
 - 4. CONSTANT SPEED SELECTED
 - 5. FAULT
- E. Digital Communications Interface: Provide an Ethernet interface allowing VFD to be used with an external system within a multi-drop LAN configuration. Interface shall

allow all parameter settings and control of VFD to be interfaced with SCADA via Ethernet TCP/IP. Provide capability for VFD to retain these settings within the nonvolatile memory.

2.10 FACTORY TEST

- A. Each controller shall be factory tested at rated full load current and an ambient temperature of 40 degrees C for a period of not less than 24 hours. If a component fails, it shall be replaced and the test shall be repeated for the full time period.
- B. A certified copy of the factory Test Report shall be furnished to the Engineer prior to shipping the controller to the job site.

2.11 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions. In the absence of more stringent warranty requirements, equipment furnished under this Section shall have a minimum 5 years on-site parts and labor warranty.
- B. Include contact details (names, addresses, telephone and fax numbers, and email if available) for warranty call-backs with the manufacturer's installation, operation, and maintenance instruction submittal.

PART 3 - EXECUTION

3.1 EXAMINATION PRIOR TO INSTALLATION

- A. Inspect areas prepared for VFD installation for compliance with manufacturer's installation instructions, installation tolerances, NEC working clearances, and other conditions affecting performance.
- B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. For wall-mounted enclosures, mount the VFD with stainless steel fasteners through the enclosure mounting holes to two or more vertical stainless steel 1-1/2 inch (40mm) channels fastened to the wall. Comply with manufacturer's installation instructions.
- B. For freestanding enclosures, anchor each VFD assembly to a concrete equipment pad in accordance with the VFD manufacturer's installation instructions. Attach with stainless steel bolts.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Control for Electrical Systems".

3.3 CONCRETE BASES

- A. Coordinate size and location of concrete equipment pad with manufacturer's installation instructions for approved equipment.
- B. Concrete materials and installation requirements are specified in Division 3.

3.4 IDENTIFICATION

- A. Identify VFDs, components, and control wiring according to Division 26 Section "Identification for Electrical Systems".
- B. Operating Instructions: Mount engraved plastic sign with simplified normal and emergency operating instructions, including constant speed operation, on front of VFD enclosure five feet above finished floor. Sign shall have white letters on black field. Lettering shall be 1/4 inch minimum height.

3.5 CONDUIT AND WIRE INSTALLATION

- A. Install power wiring, and control wiring from the pushbutton station at the motor to the VFD, in conduit as shown on the Electrical Drawings. If the VFD is adjacent to the motor, the emergency stop pushbutton shall be mounted on the VFD door, and wiring to a separate emergency stop pushbutton is not required.

3.6 FIELD TESTING AND SETUP BY VFD MANUFACTURER

- A. Prepare equipment for VFD manufacturer representative's inspection, testing, setup and acceptance tests as follows:
 - 1. Vacuum clean interior and wipe clean the exterior of each VFD equipment enclosure after removing all foreign objects and construction debris. Follow the manufacturer's instructions.
 - 2. Test insulation resistance of power and control circuits in accordance with manufacturer's installation instructions after disconnecting devices that may be damaged by test voltage and current.
 - 3. Test continuity of each external circuit with low voltage battery-operated continuity tester. Install temporary jumpers where needed to verify accuracy of point-to-point power and control wiring connections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect completed VFD installation, and review Contractor's report of tests performed prior to energization, for compliance with VFD manufacturer's instructions and recommendations. Advise the Engineer when each VFD is ready for energization.
 - 2. Setup and adjust controllers, components, and equipment after receiving permission from the Engineer to energize the VFD. Variable frequency drive startup, including setup, direction-of-rotation test, and speed command response, shall be carried out with the motor output shaft disconnected from the driven mechanical equipment.

3. After satisfactory operation of the drive (controller and motor) has been demonstrated, the mechanical equipment shall be connected to the motor shaft for mechanical equipment startup and commissioning tests.
4. Assist in startup of completed electrical and mechanical system and equipment.
5. The variable frequency motor controller manufacturer's designated representative shall supervise a running field test in the presence of the Owner and the driven mechanical equipment manufacturer's representative for a minimum of eight hours for each VFD installed. If process conditions permit, several VFD's may be field tested simultaneously.
6. The manufacturer's representative shall ensure the proper operation of each unit in manual and automatic modes over the full operating range. Test shall verify all manual and automatic controls function properly and all electrical protection devices, safeties, and trips work properly.
7. The controller manufacturer's representative shall program the available "skip frequency" ranges to avoid critical equipment frequencies when requested by the Engineer.
8. If any deficiencies are revealed, such deficiencies shall be corrected and the tests shall be repeated.
9. Submit VFD manufacturer's inspection, test, and setup test report to the Engineer for record.

3.7 ACCEPTANCE TESTING

- A. Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports.
 1. Perform electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specifications, Section 7.17 "Adjustable Speed Drive Systems".
 2. Certify compliance with test parameters.
 3. Harmonics Test: Compliance with IEEE 519 shall be verified using a calibrated harmonic voltage and current analyzer with tape record and file downloading capabilities. Voltage and current distortion through the 15th harmonic shall be verified by field measurements of the harmonic distortion difference at the point of common coupling with the VFDs operating. Measurements shall be taken by the VFD Manufacturer's Representative in the presence of the Engineer.
 4. Replace damaged and malfunctioning controls and equipment.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.
- C. Test Reports: Prepare written reports to record the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.8 DEMONSTRATION AND TRAINING

- A. Engage the services of a factory-authorized service representative to train Owner's maintenance personnel.

- B. Upon completion of the work and at a time designated by the Owner, the equipment manufacturer's authorized representative shall instruct the Owner's personnel in the programming, operation and maintenance of the variable frequency motor controllers.
- C. A proposed training course schedule and a complete description of each day's training syllabus, hour-by-hour, shall be submitted to the Owner and the Engineer at least 30 days in advance of the proposed training date. All pages of the manufacturer's instructions and recommendations for maintenance, troubleshooting, and parts replacement shall be reviewed during the training course.

END OF SECTION

SECTION 26 43 00

TRANSIENT VOLTAGE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide transient voltage surge suppression units for protection of low-voltage building electric and electronic systems, control, and communication equipment from the effects of line and induced transient voltage surges and coupled lightning discharged transients.

1.2 REFERENCES

- A. Materials and installation shall be in conformance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. Underwriters Laboratories, Inc. (UL) 1449 - Standard for Safety for Transient Voltage Surge Suppressors.
 - 2. National Electrical Code (NEC)
 - 3. The Institute of Electrical and Electronic Engineers (IEEE) ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low Voltage AC Power Circuits.

1.3 SUBMITTALS

- A. Submittals shall conform to the General Conditions.
- B. Submit manufacturer's catalog data for each product, clearly marked to show which items are proposed for this project. Cross out non-applicable information.

1.4 QUALITY ASSURANCE

- A. Uniformity: Unless otherwise specified, equipment or material of same type of classification shall be products of same manufacturer. All material shall be new and of the latest design of manufacturer providing equipment or material.
- B. Design: Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with all applicable technical standards and shall have neat and finished appearance.
- C. The surge protective device shall have a minimum of 10 years warranty.

PART 2 - PRODUCTS

2.1 GENERAL

A. MANUFACTURERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Innovative Technology Inc.
 - b. Advanced Protection Technologies, Inc.

- c. Cutler-Hammer, Inc.
 - d. Leviton Manufacturing Co. Inc.
 - e. Intermatic Incorporated
 - f. Liebert Corp.
 - g. Siemens Energy & Automation.
 - h. Square D Co.
 - i. Or approved equal.
2. When provided in a separate enclosure, provide NEMA 12 enclosure.
 3. The surge protective device shall be of the fast acting Metal Oxide Varistor (MOV) design.

B. MOTOR CONTROL CENTER SURGE PROTECTIVE DEVICES

1. Modular design with field-replaceable modules for the purpose of in-service replacement for each phase. The SPD shall provide redundancy in the event of primary phase-module failure.
2. Provide the following features and accessories:
 - a. Fuses rated at 200-kA interrupting capacity (or at a minimum the available fault current at the utility connection).
 - b. Fabrication using bolted compression lugs for internal wiring.
 - c. Integral disconnect switch.
 - d. Connection Means: Permanently wired.
 - e. Redundant suppression circuits.
 - f. Redundant replaceable modules.
 - g. Arrangement with copper busbars and for bolted connections to phase buses, neutral bus, and ground bus.
 - h. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - i. Red and green LED indicator lights for power and protection status.
 - j. Audible alarm, with silencing switch, to indicate when protection has failed.
 - k. One set of dry contacts rated at 5 a and 250-V ac, for remote monitoring of protection status.
 - l. Surge-event operations counter.
 - m. Peak Single-Impulse Surge Current Rating: 240 kA per phase.
 - n. Protection modes and UL 1449 clamping voltage for grounded wye circuits on 3-phase, 4-wire circuits, shall be as follows:
 - 1) Line to Neutral: 800 V for 480Y/277, 400 V for 208Y/120
 - 2) Line to Ground: 800 V for 480Y/277, 400 V for 208Y/120
 - 3) Neutral to Ground: 800 V for 480Y/277, 400 V for 208Y/120
 - 4) Line to Line: 1500 V for 480Y/277, 800 V for 208Y/120

C. PANELBOARD SURGE PROTECTIVE DEVICES

1. Modular design with field-replaceable modules and the following features and accessories:
 - a. Fuses, rated at 200-kA interrupting capacity.
 - b. Fabrication using bolted compression lugs for internal wiring.
 - c. Integral disconnect switch.
 - d. Redundant suppression circuits.
 - e. Redundant replaceable modules.

- f. Arrangement with copper busbars and for bolted connections to phase buses, neutral bus, and ground bus.
- g. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
- h. Red and green LED indicator lights for power and protection status.
- i. Audible alarm, with silencing switch, to indicate when protection has failed.
- j. One set of dry contacts rated at 5 a and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
- k. Surge-event operations counter.
- l. Peak Single-Impulse Surge Current Rating: 120 kA per phase.
- m. Protection modes and UL 1449 clamping voltage for grounded wye circuits on 3-phase, 4-wire circuits, shall be as follows:
 - 1) Line to Neutral: 800 V for 480Y/277, 400 V for 208Y/120
 - 2) Line to Ground: 800 V for 480Y/277, 400 V for 208Y/120
 - 3) Neutral to Ground: 800 V for 480Y/277, 400 V for 208Y/120
 - 4) Line to Line: 1500 V for 480Y/277, 800 V for 208Y/120

D. PLUG-IN SURGE SUPPRESSORS

- 1. Description: Non-modular, plug-in suppressors with at least four 15-A, 120-V ac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and accessories:
 - a. LED indicator lights for power and protection status.
 - b. LED indicator lights for reverse polarity and open outlet ground.
 - c. Circuit breaker and thermal fusing. When protection is lost, circuit opens and cannot be reset.
 - d. Circuit breaker and thermal fusing. Unit continues to supply power if protection is lost.
 - e. Cord connected with nominal 15-foot line cord.
 - f. Rocker-type on-off switch, illuminated when in the on position.
 - g. One RJ11/12C telephone line protector, suitable for modem connection. Maximum clamping voltage 220 peak on pins No. 3 and 4.
- 2. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
- 3. Protection modes and UL 1449 clamping voltage shall be as follows:
 - a. Line to Neutral: 475 V.
 - b. Line to Ground: 475 V.
 - c. Neutral to Ground: 475 V.

2.2 CONTROL AND DATA TERMINALS

- A. Protection for metallic control, data, antenna, and telephone conductors entering the building from the outside shall be as recommended by the manufacturer for the type of line being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

- A. Install TVSS units as shown on the Drawings and as recommended by manufacturer. Install ground lead bonded to equipment ground bus.

- B. Install devices for Panelboard Surge Suppressors with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground. Provide multipole circuit breakers as a dedicated disconnect for the suppressor, unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including conduit and electrical connections.
 - 1. Verify that electrical wiring installation complies with manufacturer's installation requirements.

3.3 ACCEPTANCE TESTS

- A. Testing: Perform the following acceptance tests:
 - 1. Complete startup checks according to manufacturer's written instructions.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification Inspection and Test Procedure 7.19.1 "Surge Arrestors, Low Voltage".
 - 3. Certify compliance with test parameters.
- B. Repair or replace malfunctioning units. Retest after repairs or replacements are made. Submit test report.

3.4 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, troubleshoot, and maintain surge protective devices.
 - 1. Train Owner's maintenance personnel on procedures and schedules for maintaining suppressors.
 - 2. Review data in maintenance manuals.

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide lighting fixtures with lamps, ballasts, poles, hangers, options, and accessories required for a complete lighting system installation, as shown on the Drawings and specified herein.

1.2 RELATED WORK

- A. Refer to Division 26 Section "Raceways and Boxes for Electrical Systems" for conduit, box, and fitting requirements.
- B. Refer to Division 26 Section "Low-Voltage Electrical Power Conductors and Cable" for wiring requirements.
- C. Refer to Division 26 Section "Grounding and Bonding for Electrical System" for grounding requirements.
- D. Refer to Division 26 Section "Panelboards" for panelboard requirements.
- E. Refer to Division 3 for concrete and reinforcing steel requirements for pole base construction.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standard Institute (ANSI)
 - 2. National Electric Code (NEC)
 - 3. National Electrical Manufacturers Association (NEMA)
 - 4. Underwriters Laboratories, Inc. (UL)
 - 5. Consortium for Energy Efficiency (CEE)

1.4 DEFINITIONS

- A. IES: Illuminating Engineering Society
- B. IES file: The photometry IES file of a light fixture describes the way it distributes its light into space.
- C. LED: Light-emitting diode.

- D. CRI: Color Rendering Index (sometimes called color rendition index), is a quantitative measure of the ability of a light source to reproduce the colors of various objects in comparison with an ideal or natural light source
- E. NRTL: Nationally Recognized Testing Laboratory

1.5 COORDINATION REQUIREMENTS

- A. Coordinate layout and installation of lighting fixtures with piping and HVAC equipment and ductwork.

1.6 SUBMITTALS

- A. Conform to the General Conditions.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed non-conformities. Provide short description of minor non-conformities, and detailed explanation of other non-conformities.
- C. Product Data: manufacturers' catalog data sheets for lighting fixtures, lamps, ballasts, hangers, poles, controls, and accessories, with sufficient information to demonstrate conformance to specified requirements. Include photometric data for each fixture type.
- D. Samples: submit upon Engineer's request.
- E. Manufacturer Instructions: for installation, operation, and maintenance.
- F. Closeout Submittals
 - 1. Operation and Maintenance Data
 - 2. Warranty Documentation

1.7 QUALITY ASSURANCE

- A. Qualifications of Manufacturer
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Engineer.
 - 2. T8 lamps and ballasts must be pre-qualified on the most recent product listing of the Consortium for Energy Efficiency (CEE),

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver lighting fixtures in original sealed factory cartons.
- B. Store lighting fixtures in clean dry indoor rooms with a temporary dehumidifier and electric heating to maintain the storeroom between 5 and 40 deg. C with humidity less than 90%. Comply with manufacturer's additional written instructions for storing and periodic inspection and testing.

- C. Handle lighting fixtures according to manufacturer's written instructions.

1.9 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers and catalog numbers are shown on the Drawings to establish a basis of design, and to establish the quality of materials of construction. Equivalent lighting fixtures using the equal materials for housings, housing finishes, lenses, reflectors, refractors, gaskets, and latches, and with equivalent high efficiency, low glare, and photometrics, may be submitted, and shall be acceptable if approved by the Engineer.
- B. Alternate submissions must include on a CD the manufacture's electronic IES file for the specific fixture and lamp alternate to be considered

2.2 LIGHTING FIXTURES

- A. Provide lighting fixtures and accessories as shown on the Drawings.
- B. Lighting fixtures shall be NRTL-listed and labeled.
- C. Adjustable fixtures shall be capable of being locked in position.
- D. Unpainted fixture parts shall be corrosion-resistant. Damp location, wet location, and hazardous (classified) location metallic fixture parts shall be anodized or high-purity aluminum, stainless steel, or equivalent corrosion-resistant materials.
- E. Outdoor wall-packs shall be full cutoff type.
- F. LED fixtures shall be tested following IES LM-79 and IES LM-80. Proof of testing and results shall be provided to the engineer on request..

2.3 EMERGENCY EGRESS LIGHTING

- A. Emergency egress battery units and exit lights shall be as shown on the Drawings.
- B. Provide a minimum of 90 minutes of emergency illumination during a power outage.
- C. Outdoor wall-packs required to illuminate emergency egress pathways shall be battery-backed or fitted with 12 V DC lamps and bases for emergency egress lighting, as shown on the Drawings.

2.4 LAMPS

- A. Replace all lamps broken or missing at the time of Substantial Completion.

2.5 PROGRAMMABLE OUTDOOR LIGHTING CONTROLLERS

- A. Outdoor lighting controllers shall be of the 24-Hour type, capable of permitting up to 12 ON/OFF operations each day. The time switch shall provide a minimum ON/OFF time of 1 hour. The time switch shall be powered by 120VAC, 60 Hz power supply. The time switch enclosure shall be a Type 3R with see through cover, lockable enclosure. The Time Switch shall be Intermatic Model T101P, or approved equal.
- B. Lighting Contactors shall be electrically-held type, and shall be in accordance with Division 26 Section "Enclosed Controllers".

2.6 SPARE PARTS

- A. Furnish the following special tools and spare parts for the specified equipment:
 - 1. Lamps: 10 of each type and rating installed.
 - 2. Diffusers and Lenses: Furnish at least one of each type.
 - 3. Globes and Guards: 4 of each type and rating installed..
 - 4. Four spare emergency lighting battery unit lamps(s) of each size and type provided under the Contract.
 - 5. Twelve spare emergency battery lighting unit batteries(s) of each size and type provided under the Contract.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead and ceiling work of other trades is complete.
- C. Verify that ground connections are in place and that installation of equipment grounding conductors described in Division 26 Section "Grounding and Bonding for Electrical Systems" is complete.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. All lighting equipment shall have enclosures, hangers and supports, fittings and outlet boxes suitable for the location as specified in Division 26 Section "Electrical - General".
- B. Lighting fixture locations shown on the Drawings are approximate. Exact locations shall be coordinated with piping, ductwork, and structural components to avoid interferences with HVAC ducts and equipment, plumbing systems, process piping, roof drains, and other interferences.
- C. Mounting height for fixtures shall be as shown on the Drawings. Where no mounting height is shown, fixtures shall be mounted to give the minimum of shading from pipes, ducts, beams and other obstructions.

- D. Pendant type fixtures shall be suspended by means of conduit stems and ball hangers from outlet boxes in non-hazardous areas, and shall be mounted with 12 inch minimum length explosion-proof couplings in Hazardous (Classified) Locations. Threaded connections shall be locked with set screws or equivalent methods. Verify field conditions for mechanical and structural interferences prior to locating outlet boxes for pendant mounted lighting fixtures..
- E. Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general cleanup. Handle carefully handled to avoid scratching.
- F. Provide nighttime adjustment of all adjustable lighting units and floodlighting, etc. as required to satisfaction of Engineer.
- G. Where fixtures are installed in suspended ceiling, each fixture shall be anchored securely to grid system by means of caddy clips or T-Bar hangers manufactured by Tomic Electric or equal.
- H. Wiring for Exit Lighting and Emergency Lighting circuits shall be installed in separate raceway systems in accordance with the NEC.
- I. Lighting circuits for battery-powered emergency lights and exit lights shall be connected to the unswitched room lighting circuit conductors in accordance with the NEC.
- J. Concrete pole bases shall be installed as shown on the Drawings. Refer to Division 3 for cast-in-place concrete and reinforcing steel requirements. Align poles plumb and grout pole bases on the day of pole installation.

3.3 FIELD QUALITY CONTROL

- A. Prepare for lighting fixture circuit energization as follows:
 - 1. Test continuity and insulation resistance for each power supply circuit.
 - 2. After installing equipment but before power supply is energized, verify that grounding system is completed.
 - 3. Verify that equipment is installed and connected according to the Contract Documents
 - 4. Fixtures and rooms with occupancy sensors will be tested and commissioned immediately after the space is fully occupied. Commissioning procedure will be submitted by the contractor and approved by the engineer.

3.4 CLEANING

- A. On completion of installation, inspect interior and exterior of lighting fixtures. Remove dust, dirt, paint splatters and other spots from exterior and wipe down with damp cotton cloth. Touch up exposed surfaces to match original finish. Vacuum interior surfaces "white glove clean", removing all dirt and debris while taking care to protect static-sensitive and fragile parts from damage. Do not use compressed air to assist in cleaning.

3.5 PROTECTION

- A. Lighting fixtures shall be left in clean, operational condition, free of dirt and cosmetic defects.
- B. Protect installed equipment from damage through Substantial Completion.

3.6 FOLLOW-UP SERVICE

- A. Monitoring and Adjusting: Approximately 6 months after Substantial Completion, and prior to Contract Closeout, perform the following monitoring and adjusting tasks:
 - 1. Inspect installed lighting fixtures for non-functioning lamps.
 - 2. Inspect correct operation of photocell and timer controls.
 - 3. Test emergency lighting fixtures for proper performance by de-energizing room lighting systems for 90 minutes.
 - 4. Corrective Action: If test results are unacceptable, determine the cause of failure and repair fixtures to fully functional operation.
 - 5. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
 - 6. Report: Prepare a written report covering monitoring performed and corrective action taken.

END OF SECTION

SECTION 31 00 00

AGGREGATE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes aggregate base course for pavement (ODOT 304), aggregate for pipe bedding (#57 stone), stone for outlet protection (Rip-Rap) and stone for rock ditch checks (gabion).

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Massillon Waste Water Treatment Plant.

1.4 INFORMATIONAL SUBMITTALS

- A. Quarry's certifications for the production of each type of aggregate.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Aggregate base course for pavement- Meet the specifications set forth by section 304 of the ODOT Construction and Material Specifications, Latest Edition, for all aggregate to be used under the asphalt and concrete pavement sections as well as the concrete sidewalks and elsewhere that this item is noted on the plans. Gradation samples and compaction tests will need to be obtained as per the ODOT Specifications.
- B. #57 Stone- Meet the requirements of AASHTO M43 for gradation and AASHTO T96 for wear. This stone is to be used in pipe trenches for bedding as required by the plans or by the Owner. Gradation samples will need to be taken each day of delivery of stone to the project.
- C. Rip-Rap – Shall meet a visual inspection to insure that the stones are a maximum of 9” with an average size of 6”.
- D. Gabion stone – Shall meet a visual inspection to insure the stone sizes are within the 3”- 6” range.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Class 1 Aggregate 307001-001 – Subgrade shall be properly prepared and graded as per Section 31 20 00 “Earthwork” and inspected prior to placing stone or fabric for separation in areas where it is required..
- B. #57 Stone – Pipe trench excavated as per Section 33 05 00 “Trenching” and inspected before placing stone.
- C. Rip-Rap – The area for the Rip-Rap outlet protection shall be excavated to plan grade in accordance to Section 31 20 00 “Earthwork” and inspected prior to placing the filter fabric and stone.
- D. Gabion Stones – The planned ditch lines shall be constructed prior to placing the Gabion Stone for the Rock Ditch Checks.

3.2 PLACEMENT

- A. ODOT 304 Aggregate - Placement of stone, tolerances, and compaction requirement are set forth by ODOT Construction and Material Specifications, Latest Edition.
- B. #57 Stone – The placement of stone shall be by hand or mechanical. The stone shall be consolidated with a vibraplate prior to the placement of pipes.
- C. Rip-Rap – The stones are to be placed mechanically with some hand work necessary to place stones along edges and next to structures. Rip-Rap outlet shall be constructed as per the dimensions given on the Contract drawings.
- D. Gabion Stones – Placed as Rock Ditch Checks as per the Contract Drawings

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SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Removing above- and below-grade site improvements.
 - 6. Disconnecting, capping or sealing site utilities.
 - 7. Temporary erosion- and sedimentation-control measures.

1.3 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining streets, drives, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated in Section 02 41 19 "Demolition."
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Work."
 - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site

- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Engineer.

3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Owner not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Owner's written permission.
- C. Removal of underground utilities is included in earthwork sections and with applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security and utilities sections and Section 024119 "Demolition."

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 - 2. Use only hand methods for grubbing within protection zones.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover or temporary seed to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

* * * * *

SECTION 31 10 50

EROSION & SEDIMENT MEASURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and as any relevant Ohio Environmental Protection Agency (OEPA) permits, apply to this Section.

1.2 SUMMARY

- A. Section includes the following items:
 - 1. Dewatering Silt Sack
 - 2. Super Silt Fence
 - 3. Rock Ditch Checks
 - 4. Rip-Rap Outlet Protection
 - 5. Stream Pump Around
 - 6. Sediment Traps
 - 7. Temporary Diversion Dikes

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Massillon Waste Water Treatment Plant with Engineer and City's representative.

1.4 INFORMATIONAL SUBMITTALS

- A. Dewatering Silt Sack- Certification showing that the product meets the requirements ASTM D-4632, ASTM D-4833, ASTM D-4491, ASTM D-3786, ASTM D-4355, ASTM D-4751.
- B. Super Silt Fence- Certification showing that the filter fabric meets the minimum requirements set forth by AASHTO M288, Section 7, Class 1.
- C. Rock Ditch Checks – No submittals required
- D. Rip-Rap Outlet Protection - No submittals required for rock. Certification showing that fabric for separation meets the requirements of ASTM D-1777 and ASTM D-1682.

- E. Stream Pump Around – No submittals required for sand bags or pumping apparatus. Certification showing that the Dewatering Silt Sack meets the same ASTM specifications as in Section 1.3.A.
- F. Sediment Traps – No submittals required.
- G. Temporary Diversion Dikes – No submittals required.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Engineer's or Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Silt Sack- Certification showing that the product meets the minimum criteria listed:

1.	Grab Tensile	ASTM D-4632	250 #
2.	Puncture	ASTM D-4833	165 #
3.	Flow Rate	ASTM D-4491	70 gal/min/sf
4.	Permittivity	ASTM D-4491	1.3 sec-1
5.	Mullen Burst	ASTM D-3786	550 #/si
6.	UV Resistant	ASTM D-4355	70 %
7.	AOS% Retain	ASTM D-4751	100%

Shall also have an average wide width strength per ASTM D-4884 of 100 #/in.

- B. Super Silt Fence- Certification showing that the filter fabric meets the minimum requirements set forth by AASHTO M288, Section 7, Class 1. Super Silt Fence shall be sturdy enough to remain upright during rain events to allow the water to filter through.
- C. Rock Ditch Checks – Rock shall be of good quality rock that will not be readily broken down over time. Shall be 3”-6” rock free of fines to allow water to flow through.

- D. Rip-Rap Outlet Protection - Certification showing that fabric for separation meets the requirements of ASTM D-1777 and ASTM D-1682. Rip-Rap shall be of good quality rock that will not be readily broken down over time. Shall be 3"-9" rock with a d50 = 6" and free of fines to allow water to flow through.
- E. Stream Pump Around – Certification showing that the Dewatering Silt Sack meets the same criteria as in Section 2.1.A. Pumps need to be well maintained to continuously pump water around the work site. A second operating pump must be kept on site in the case of an emergency. The sand bags and liner must be able to retain all water coming into the pumping area. Intake must be kept up off the bottom to help with sedimentation issues.
- F. Sediment Traps – No performance requirements necessary, however it shall be constructed into original ground, with a stabilized and protect outfall.
- G. Temporary Diversion Dikes – No performance requirements necessary for straw/hay bales (not allowed in ditch lines) or earthen material.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Dewatering Silt Sack –
 - 1. The ground need to be on a very slight slope so incoming water flows downhill through the sack without creating more erosion.
 - 2. The ground must be free from sticks, roots, rocks or any other foreign matter that may snag or rip the silt sack. For best results place sack on a bed of straw.
- B. Super Silt Fence- Surveyor should layout the line for the Super Silt Fence to insure that it is just outside of the work area and will not need to be moved.
- C. Rock Ditch Checks – permanent ditch lines should be constructed to final grade as per Section 31 20 00 "Earthwork" and inspected prior to place rock ditch checks.
- D. Rip-Rap Outlet Protection –
 - 1. Area of the Outlet Protection shall be excavated as per Section 31 20 00 "Earthwork" and to the dimensions as shown on the Contract Drawings.
 - 2. Area needs to be inspected and approved before Separation Fabric is placed.
- E. Stream Pump Around –
 - 1. Plan to utilize this method during low flow periods.

2. The Dewatering Silt Sack and pumps shall be set up before the sandbags and liner are installed.
- F. Sediment Trap Shall be excavated as per Section 31 20 00 "Earthwork".
- G. Temporary Diversion Dikes – Vegetative matter shall be stripped from area where diversion ditches are to be constructed.

3.2 PLACEMENT

A. Dewatering Silt Sack-

1. Place Sack on a slight slope.
2. The neck of the Filter Sack shall be tightly strapped (minimum of 2 straps) to the discharge hose.
3. Place sack on a bed of straw

B. Super Silt Fence –

1. Shall be place as shown on Contract Drawings
2. The chain link fence shall be fastened securely to the fence posts with wire ties or staples.
3. Geotextile shall be fastened securely to the chain link fence with ties every 24 inches at the top and midsection.
4. Geotextile shall be embedded a minimum of 12" into the ground.
5. When 2 sections of geotextile fabric adjoin, they shall be overlapped by 6 inches and folded.
6. Metal posts can be replaced by 4"x4" wood posts.

C. Rock Ditch Checks-

1. Rock shall be placed as shown on the Contract Drawings

D. Rip-Rap Outlet Protection –

1. Place separation fabric so as to line the entire bottom and sides of the excavated area. If overlapping is necessary, overlap a minimum of 2'.
2. Rock can be place mechanically but should be rearranged by hand along the edges and structures to insure proper coverage.
3. Place as shown on Contract Drawings

E. Stream Pump Around –

1. Once the dewatering silt sack and pumps are ready, begin placing sand bags and liner to insure that the dam is impervious to water
2. Suspend the inlet of the pump above the streambed in order to prevent sucking mud and sediment.
3. Begin pumping, keeping a close watch that the pump is sufficient enough to handle the flow. If not, increase the pump size or add an additional pump and dewatering silt sack.
4. Continuous pumping will be necessary until work in this area is complete.

F. Sediment Traps –

1. Shall be excavated as per Section 31 20 00 “Earthwork” into original ground and have a stabilized outfall.
2. They shall be placed at the foot of embankments where temporary and permanent slope drains or diversion dikes outlet.
3. At the bottom as well as in the ditch lines of waste sites and borrow pits.
4. At the downgrade ends of a cut section when saturation of this area would not harm the area.

G. Temporary Diversion Dikes –

1. Shall be constructed along the top, middle or bottom of slopes in order to collect storm run-off and divert it to other sediment control features.
2. The top of earthen perimeter controls designed as temporary flow diversion measures should be at least 2 feet wide. The bottom width at ground level is typically 6 feet. The minimum height for earth dikes should be 18 inches, with side slopes no steeper than 2:1.
3. If a channel is excavated along the dike, its shape can be parabolic, trapezoidal, or V-shaped.

3.3 MAINTENANCE

A. Dewatering Silt Sack –

1. Inspect frequently during pumping operations.
2. Replace once the sediment buildup prevents the structure from functioning properly.

3. At the end of its use, the silt sack can be cut open and the accumulated sediment can be spread on site and stabilized or disposed of at an approved waste site.
4. The silt sack must be disposed of properly.

B. Super Silt Fence –

1. Super silt fence shall be inspected every 7 calendar days and within 24 hours of every rain event greater than 0.5” of rain in a 24 hour period.
2. Any necessary repairs shall be made immediately.
3. Any fabric that shows signs of decomposing or become ineffective shall be promptly replaced.
4. Sediment deposits shall be removed and disposed of properly when deposits reach approximately ½ the height of the barrier.

C. Rock Ditch Checks –

1. Rock ditch checks shall be inspected every 7 calendar days and within 24 hours of every rain event greater than 0.5” of rain in a 24 hour period.
2. Sediment deposits shall be removed and disposed of properly when deposits reach approximately ½ the height of the barrier.
3. Replace any rocks that may get displaced by rushing water. If this reoccurs, larger stones may need to be placed.

D. Rip-Rap Outlet Protection –

1. Shall be inspected every 7 calendar days and within 24 hours of every rain event greater than 0.5” of rain in a 24 hour period.
2. Any major debris such as wood and leaves shall be removed and disposed of properly.
3. Any major sediment deposits shall be removed and disposed of properly.

E. Stream Pump Around –

1. Shall be inspected several times throughout the day to ensure that the pump(s) is/are keeping up with the inflow.
2. Check for water infiltrating the work area through the coffer dam.
3. Inspect the dewater silt sack daily and replace once the sediment buildup prevents the structure from functioning properly. See section 3.3.A for disposal.
4. Keep an additional pump on site in case of a failure.

F. Sediment Traps –

1. Shall be inspected every 7 calendar days and within 24 hours of every rain event greater than 0.5” of rain in a 24 hour period.
2. Once the capacity of the trap is 50 percent filled with sediment, the accumulated sediment is to be removed and disposed of in an appropriate manner.

G. Temporary Diversion Dikes –

1. Inspect earthen diversion dikes after each rainfall to ensure continued effectiveness.
2. Maintain dikes at their original height. Repair any decrease in height due to settling or erosion immediately.
3. To remain effective, earth dikes must be compacted at all times.
4. Regardless of rainfall frequency, inspect dikes at least once every 2 weeks for evidence of erosion or deterioration.

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SECTION 31 20 00

EARTHWORK

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

A. Work Included

- 1. Site Clearing
- 2. Extent of earthwork is indicated on drawings. Preparation of subgrade for pavement is included as part of this work.
- 3. Excavation and backfilling of trenches is included as part of this work
- 4. Topsoiling, temporary and final seeding where applicable, is included as a part of this work.
- 5. Definition: "Excavation" consists of removal of material encountered to subgrade elevations indicated (including pipelines) and subsequent disposal of materials removed.

B. Related Work Specified Elsewhere

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.3 SUBMITTALS:

- A. Test Reports-Excavating: Submit following reports directly to Engineer from the testing services, with copy to Contractor:
 - 1. Field density test reports.
 - a. One optimum moisture-maximum density curve for each type of soil encountered.

1.4 QUALITY ASSURANCE

- A. Codes and Standards Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

- B. Testing and Inspection Service. An independent testing laboratory will be hired by the contractor to perform soil testing and inspection service for quality control testing during earthwork operations.

1.5 JOB CONDITIONS

- A. Existing Utilities: Prior to beginning construction locate any existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.
- B. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
- C. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
- D. Provide minimum of 48-hour notice to Engineer, and receive written notice to proceed before interrupting any utility.
- E. Use of Explosives: Do not bring explosives onto site or use in work without prior written permission from authorities having jurisdiction. Contractor is solely responsible for handling, storage, and use of explosive materials when their use is permitted. Explosives will not be stored overnight on site. Contractor will be responsible for any/all permits required.
- F. Protection of Persons and Property: Barricade (fence) open excavations occurring as part of this work and post with warning lights.
- G. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
- H. As applicable, perform excavation within drip-line of large trees to remain by hand, and protect the root system from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with emulsified asphalt tree paint.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS:

- A. Definitions: Satisfactory soil materials are defined in The ODOT Construction and Material Specifications, Latest Edition. Unsatisfactory soil materials are defined as those not complying with the above definition and topsoil or peat moss.
- B. Aggregate Base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, natural or crushed sand. (ODOT Section 304)

- C. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100% passing a 1-1/2" sieve and not more than 5% passing a No. 4 sieve. (AASHTO #57 stone)
- D. Backfill and Fill Materials: Satisfactory soil materials free of clay, rock or gravel larger than 2" in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.
- E. Structural Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, natural or crushed sand. (ODOT Section 304).

PART 3 - EXECUTION

3.1 EXCAVATION

- A. During all work, access to the existing process buildings must be maintained throughout the project.
- B. Clearing and Grubbing: Prior to all earthwork, clearing and grubbing and disposal of all trash, trees, stumps, brush and waste material off site, must be done.
- C. Excavation Classifications: All earthwork is unclassified. No additional payments will be made for excavation of rock, unless a rock clause is negotiated with the bid. Geotech report shows all material favorable for excavation without the need for blasting.
- D. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at Contractor's expense.
- E. Backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Engineer.
- F. Additional Excavation: When excavation has reached required subgrade elevations, notify Engineer who will make an inspection of conditions.
- G. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material as directed by Engineer. Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to changes in work.
- H. Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
- I. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

- J. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
- K. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations. See Section 31 23 19.
- L. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- M. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
- N. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
- O. Dispose of excess soil material and waste materials as herein specified.
- P. Excavation for Pavements: Cut surface under pavements to comply with cross-sections, elevations and grades as shown.
- Q. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of pipe or conduit unless otherwise shown in the construction drawings.
- R. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups.
- S. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of water and sewer pipe. For culvert pipe use clay type soil.
- T. For pipes or conduits 5" or less in nominal size and for flat-bottomed multiple-duct conduit units, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
- U. For pipes or conduits 6" or larger in nominal size, tanks and other mechanical/electrical work indicated to receive subbase, excavate to subbase depth indicated, or, if not otherwise indicated, to 6" below bottom of work to be supported.
- V. Except as otherwise indicated, excavate for exterior water-bearing piping (water, steam, condensate, drainage) so top of piping is not less than 3'-6" below finished grade.

- W. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
- X. Backfill trenches with concrete where trench excavations pass within 18" of column or wall footings and which are carried below bottom of such footings, or which pass under wall footings. Place concrete to level of bottom of adjacent footing.
- Y. Do not backfill trenches until tests and inspections have been made and backfilling authorized by Engineer. Use care in backfilling to avoid damage or displacement of pipe systems.

3.2 COMPACTION

- A. General: Control soil compaction during construction providing minimum percentage of density specified for each area classification as indicated below.
- B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils) determined in accordance with ASTM D 1557; and not less than the following percentages of relative density, determined in accordance with ASTM D 2409, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
- C. Pavement and Shoulder Areas: Compact top 12" of subgrade and each layer of backfill or fill material at 90% maximum density for cohesive material or 95% relative density for cohesionless material.
- D. Unpaved Areas: Compact top 6" of subgrade and each layer of backfill or fill material at 85% maximum density for cohesive soils and 90% relative density for cohesionless soils.
- E. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations. Moisture will be controlled to $2\% \pm$ of optimum.
- F. Remove, scarify, and air dry, soil material that is too wet to permit compaction to specified density.
- G. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.3 BACKFILL AND FILL:

- A. General: Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.
 - 1. In excavations, use satisfactory excavated or borrow material.
 - 2. Under grassed areas, use satisfactory excavated or borrow material.

3. Under pavements, use aggregate base material, as indicated or satisfactory excavated or borrow material, or combination of both.
 4. Under piping and conduit, use aggregate base material where under piping or conduit; shape to fit bottom 90 deg of cylinder.
 5. Backfill excavations as promptly as work permits, but not until completion of the following:
 - a. Inspection, testing, approval, and recording locations of underground utilities.
 6. Removal of trash and debris from site and dispose property at a permitted landfill.
- B. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
- C. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture/condition to optimum moisture content, and compact to required depth and percentage of maximum density.
- D. Placement and Compaction: Place backfill and fill materials in layers not more than 8" in loose depth for material compacted by heavy compaction equipment, and not more than 4" in loose depth for material compacted by hand-operated tampers.
- E. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- F. Place backfill and fill materials evenly adjacent to piping or conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping or conduit to approximately same elevation in each lift.

3.4 GRADING

- A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.
- B. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10' above or below required subgrade elevations.
- C. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10' above or below required subgrade elevation.

- D. Pavements: Shape surface of areas under pavement to line, grade and cross-section, with finish surface not more than 1/4" above or below required subgrade elevation.
- E. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.5 PAVEMENT AGGREGATE BASE COURSE

- A. General: Aggregate base course consists of placing subbase material, in layers of Specified thickness, over subgrade surface to support a pavement base course. See other Division-32 sections for paving specifications.
- B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.
- C. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations. When a compacted subbase course is shown to be 6" thick or less, place material in a single layer. When shown to be more than 6" thick, place material in equal layers, except no single layer more than 6" or less than 3" in thickness when compacted.

3.6 FIELD QUALITY CONTROL:

- A. Quality Control Testing During Construction: Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed. Perform field density tests in accordance with ASTM D 1556 (sand cone method), ASTM D 2922-78 (Nuclear Gauge Method) or ASTM D 2167 (rubber balloon method), as applicable.
- B. Paved Areas: Make at least one field density test of subgrade for every 100 feet of roadway, but in no case less than 3 tests. In each compacted fill layer, make one field density test for every 100 feet of roadway per day of fill operation, but in no case less than 3 tests.
- C. If in opinion of Engineer, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction, scarification, etc. and testing at no additional expense.

3.7 MAINTENANCE:

- A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.
- D. Settling : Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill

material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.8 DISPOSAL OF EXCESS AND WASTE MATERIALS.

- A. Waste Material: Transport waste material, including unacceptable excavated material, trash and debris to legal landfill off of Owner's property.

* * * * *

DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Revised Subsurface Investigation submitted by S&ME, Inc. on September 25, 2014 and associated Addendum No. 1 submitted by S&ME, Inc. on November 12, 2014, collectively referred to in this Section as the "Report".

1.2 SUMMARY

- A. Section includes control of groundwater to permit construction in the dry and on stable subgrades.
- B. Performance Criteria
 - 1. Dewatering as required to maintain the groundwater level at least 3 feet below the lowest required excavation depth for the following structures (Elevations provided are excavation grades not dewatering requirements).
 - a. Primary Effluent Pump Station – Plant El 60.2 feet
 - b. Anaerobic/Anoxic Tanks – Plant El 66.5 feet
 - c. IR Wells & Secondary Distribution Box – Plant El 71.0 feet
 - d. Influent Flow Meter Vault – Plant El. 63.07 feet
 - e. Odor Control Building foundations – Plant El. 80.83 feet
 - f. Waste Gas Burner – Plant El.76.25
 - g. Any other new structure shown on the Contract Documents for this Project
 - 2. Lowering of groundwater shall be continuous during construction and shall be maintained until backfill is placed to final grades.
 - 3. Additional dewatering shall be required as needed for the construction of crane pads, and/or other items not shown on the plans but required by the Contractor's means and methods.
 - 4. Design of System shall be adequate to control groundwater assuming a static water condition up to the 100-year flood elevation of the Tuscarawas River at the site (Plant El. 81.9).

5. Contractor to assume direct recharge of the dewatered zone from the Tuscarawas River.

C. Regulatory Requirements

1. Obtain all required Federal, State or Local permits and approval from ODNR, OEPA and any other government agency with authority over the removal and release of groundwater to adjacent Waters of the US. Comply with governing notification regulations before beginning dewatering.
2. Comply with hauling and disposal regulations of authorities having jurisdiction. At a minimum, the following will be required:
 - a. aeration to increase dissolved oxygen;
 - b. oxidation of iron in groundwater;
 - c. sufficient detention times in on-site basins for precipitates to settle;
 - d. thermal discharges complying with in-stream temperature Water Quality Standards; and,
 - e. proper disposal of precipitates.

1.3 QUALITY ASSURANCE

- A. Dewatering Contractor Qualifications: Dewatering Contractor to install dewatering wells shall have a minimum of 5 continuous years of experience in the field of Construction Dewatering.
- B. Designer Qualifications: Dewatering Designer shall be a professional engineer or geologist licensed in the state of Ohio and have a minimum of 5 years of experience in the field of Construction Dewatering.
- C. Dewatering Plan: Contractor shall provide information on proposed well designs, installation procedures, and system testing.
- D. Dewatering Reports: Contractor provide information on operation of the system including monitoring results and maintenance performed.
- E. Survey Reports: Contractor shall monitor, provide information on settlement of adjacent structures which may be the result of dewatering activities, measure and report the level of the water in the Tuscarawas River.

1.4 PRE-INSTALLATION MEETING

- A. Pre-installation Conference: The Contractor shall conduct an on-site conference at the Massillon Waste Water Treatment Plant with the Contractor's Superintendent, the dewatering contractor site superintendent, the Designer of the dewatering system, the Engineer, and others requested to be present by the Owner.
- B. Contractor to notify Owner and Engineer at least 48 hours prior to the conference.

- C. Review methods and procedures related to dewatering including, but not limited to, the following:
 - 1. Inspection and discussion of condition of site to be dewatered including coordination with temporary erosion control measures.
 - 2. Revised Subsurface Investigation and associated Addendum No. 1.
 - 3. Dewatering Plan reviewed by the Engineer.
 - 4. Proposed site clearing and excavations.
 - 5. Existing utilities and subsurface conditions.
 - 6. Coordination for interruption, shutoff, capping, and continuation of utility services.
 - 7. Construction schedule.
 - 8. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 9. Testing and monitoring of dewatering systems.

1.5 PROJECT CONDITIONS

- A. Subsurface Investigation: The Contractor shall review the Report prepared by S&ME, Inc. for this Project.
- B. Plans and Specifications: The Contractor shall review the Contact Drawings and specifications for this Project.
- C. Site Conditions: The Contractor shall visit the site to determining the locations of the dewatering wells as well as ingress and egress to well sites.
- D. Underground Protection: The Contractor shall contact OUPS and OGPUPS at least 48 hours prior to installing any wells, and re-contact these agencies as required by these agencies. The Contractor shall contact all utilities whether included on the agency supplied lists or not. The Contactor shall review the plans of the existing plant and have the proposed well locations approved by plant personnel before drilling.

1.6 SUBMITTALS

- A. With Bid
 - 1. Contractor shall submit the name, company name, address, phone number, and resume of the proposed Designer and proposed Dewatering Contractor.
 - 2. Lists of 5 successfully completed projects for both the Designer and the Dewatering Contractor with project name, location, date, number of wells, pumping rate, client contact and phone number.

B. Within 2 weeks of signed contract:

1. Dewatering Plan: Contractor shall prepare and submit a detailed plan, stamped and signed by the professional engineer or geologist responsible for its preparation. This plan shall include, at a minimum, the following:
 - a. System Layout Drawings depicting wells/well points; monitoring wells, risers, headers, discharge lines, pumps, power units, electric lines, discharge lines, and flow monitoring devices, and means of discharge, control of sediment, and disposal of water.
 - b. The Designer shall determine whether monitoring wells will be included in the design. If utilized, the Plan shall include the details on how the monitoring wells will be constructed, developed, maintained, and abandoned.
 - c. Details for wells, well screens, and filter packs.
 - d. Description of well installation methods to include development and abandonment.
 - e. Description of dewatering operations including pump activation/deactivation methods, means of discharge, control of erosion, and methods of measuring discharge flow rate.
 - f. Descriptions of methods to be used to protect system from other construction activities and traffic.
 - g. Description of potential problems including procedures to be adopted if dewatering problems arise.
 - h. Provide a copy of calculations signed and sealed by the professional Engineer or geologist responsible for preparation of the calculations. Minimum calculations to be provided include determination of number/spacing of wells, discharge rate, and screen/filter design to minimize pumping of fines.

C. During Project

1. Dewatering Reports – submit by 8 am on the Tuesday following the reporting week (Sunday through Saturday). Reports to include, at a minimum, the following:
 - a. Water level in each well and any existing or proposed monitoring wells.
 - b. The daily pumping rate from each well;
 - c. Total water pumped from the system during the reporting week; and,
 - d. Any problems encountered and how the problems were resolved.
2. Survey Reports – submit within 24 hours of completion of surveying

- a. At the Pre-Installation meeting the Engineer will identify not more than 20 monitoring points on the project site to be monitored by the Contractor before and during dewatering activities as per the requirements of Sections 1.3.E and 3.1.A and 3.4.A. During each monitoring event, the Surveyor shall survey the water level in the Tuscarawas River adjacent to the Primary Effluent Pump Station construction.
3. Well Installation Reports – submit within 48 hours of the completion of well development. Report to include, at a minimum, the following:
 - a. Description of drilling, well installation, and well development methods;
 - b. Well Log; and,
 - c. Results of Total Suspended Solids measurement.
4. Water Discharge Reports – submit within 48 hours of submittal to regulatory agencies.
 - a. Reports to be prepared if required by regulatory agencies.
 - b. Copy of report to be submitted to regulatory agencies to be provided to Owner.

PART 2 - PRODUCTS

- 2.1 The Contractor shall use dewatering products in accordance with the recommendations of the manufacturers.
- 2.2 The product selection shall conform to the Dewatering Plan.
- 2.3 A flow meter with the accuracy of one gallon per minute and a total quantity gage with an accuracy of 10 gallons shall be placed within the discharge line of each dewatering well.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Initial Survey Work: Contractor shall engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish the elevations at fixed points to act as monitoring locations. The Engineer will select no more than 20 monitoring locations. The Contractor shall also survey the elevation of the water in the Tuscarawas River adjacent to the Primary Effluent Pump Station construction. The reference Benchmark shall be located at least 1,000 feet from any dewatering wells. All elevations shall be accurate to 0.01 foot.
- B. Provide temporary grading to facilitate dewatering, control surface water, and minimize ponding.

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DEWATERING

- C. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 31 10 00 "Site Clearing," and Section 31 10 50 "Erosion and Sediment Measures" during dewatering operations.
- D. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
 - 1. Notify Construction Manager no fewer than 14 days in advance of proposed interruption of utility.
 - 2. Do not proceed with interruption of utility without Construction Manager's written permission.
- E. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
- F. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Construction Manager and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, any monitoring wells, complete with pump equipment, standby power, pumps, filter material gradation, valves, water meters, other appurtenances, water disposal systems, electrical systems, and surface-water controls.
- B. Well development shall continue until test for Total Suspended Solids (TSS) in accordance with applicable ASTM methods indicates TSS concentration is less than 5 parts per million.
- C. The dewatering wells and the plumbing shall be established in a manner to permit the groundwater level to be measured at each dewatering well.
- D. Install piping as required to permit construction activities.
- E. Protect discharge pipes from damage from construction traffic using steel casing and stone or other method which protects the discharge lines.
- F. Provide standby equipment on-site and available for immediate operation, to maintain continued dewatering if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

3.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed to final grades, or until dewatering is no longer required as determined by the Engineer.
- B. Operate system to lower and control groundwater to permit excavation, construction of structures, and placement of fill materials on dry subgrades.
- C. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and/or slope instability.
- D. Maintain groundwater level a minimum of 36 inches below bottom of lowest excavations until backfill is placed to final grades.
- E. Complete additional TSS testing if directed by Engineer. Additional testing will be required if indications are evident that removal of groundwater is resulting in piping of soil particles. Dewatering wells resulting in "piping" shall be replaced at no additional expense to the Owner. Wells, sump pits, underdrains or any other drainage systems which have any evidence of causing piping shall be properly abandoned in such a way that future piping of soil will not result.
- F. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, aeration, and other flow-control devices as required by authorities having jurisdiction. In no case shall water be discharged to sanitary sewers.
- G. Complete daily inspections of system to assure erosion control, stability of excavations, excavations do not flood, and no damage to the subgrades.
- H. Protect system from freezing.
- I. Any damage caused by or resulting from dewatering operations shall be the sole responsibility of the Contractor. Promptly repair damages to any facilities caused by dewatering.
- J. Quickly remove pooled water on completed subgrades, remove soils damaged by pooled water, and replace with acceptable subgrade material.
- K. Remove dewatering system from Project site on completion of dewatering.
 - 1. Abandon dewatering and/or monitoring wells in accordance with the well abandonment procedures of the Division of Water of the Ohio Department of Natural Resources.
 - 2. The Contractor shall be responsible for any damage or injury caused by the inadequate backfilling of dewatering and/or monitoring wells.

3.4 FIELD QUALITY CONTROL

- A. Survey – Contractor shall survey the elevations of the no more than 20 monitoring locations and the surface water level in the Tuscarawas River at the selected location six (6) times during construction as directed by the Engineer. Survey shall be performed within 3 working days of the request.
 - 1. Promptly notify Engineer if changes in elevations of more than .05 feet, or if cracks, sags, or other damage is evident in adjacent construction.
- B. On a daily basis, measure water levels in wells, record flow rates, and total quantity of removed from each well.
 - 1. Report any problems encountered or anticipated to the Engineer the day it is observed or anticipated.

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SECTION 31 23 23.11

SELECT FILL

PART 1- GENERAL

1.1 SUMMARY

- A. This Section includes select fill materials used in either embedment or special backfill as specified, shown on the Contract Drawings, or as directed by the Engineer.

1.2 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - a. D422 - Method for Particle-Size Analysis of Soil
 - b. D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft - lbf/ft³) (600 kN-m/m³)

1.3 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions and Division 01, the following items shall be submitted:
 - 1. The name and location of the source of the material.
 - 2. Test reports of the material.
 - 3. Gradation curves and data for each select fill or special backfill material required during construction.

1.4 DEFINITIONS

- A. Embedment or Lining
 - 1. Any type granular material specified or directed to be placed below an imaginary line drawn one foot above the inside diameter of the pipe and within the trench limits.
- B. Special Backfill
 - 1. Pipelines

Any select fill material specified or directed placed above an imaginary line drawn one foot above the inside diameter of the pipe and within the trench limits.

2. Structures

Any select fill material specified or directed placed within the excavation limits, either in, under or adjacent to the structure.

C. Special Granular Material

1. Special granular material shall mean any of the granular materials listed below or other materials ordered by the Engineer.

1.5 TESTING REQUIRED

- A. All testing services, as specified herein, necessary for the Contractor to obtain approved select fill material shall be provided by the Contractor. All testing including laboratory and field services required during construction shall be provided by the Contractor.
- B. All select fill materials shall be, at a minimum, tested for compaction in accordance with ASTM D 698 and grain size in accordance with ASTM D422. Both tests shall be conducted at a frequency of one test per 500 cubic yards of material. In the event that less than 500 cubic yards of a given select fill material is to be used, at least one test for that material shall be supplied.

PART 2 - PRODUCTS

2.1 GRANULAR MATERIALS

- A. ODOT Department of Transportation (ODOT) Coarse Aggregate
 1. Coarse Aggregate No. 1 and No. 57 shall be in accordance with Section 703 of the current revision of the ODOT Construction and Materials Specifications.
- B. Pipe Bedding and Backfill Aggregate
 1. Pipe Bedding and Backfill Aggregate shall be in accordance with Section 703.11, Type 1 of the current revision of the ODOT Construction and Materials Specifications.
- C. Subbase and Aggregate Base Material
 1. Subbase and Aggregate Base Material shall be in accordance with Section 703.17 of the current revision of the ODOT Construction and Materials Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. ODOT aggregate shall be placed in accordance with applicable 300 section of the current revision of the ODOT Construction and Materials Specifications.
- B. Special granular material as specified or directed for pipeline embedment shall be placed in accordance with the Section 33 05 00 entitled "Trenching, Backfilling and Compacting".
- C. Special backfill where specified or directed shall be placed in accordance with the backfilling provisions of the Section entitled "Trenching, Backfilling, and Compacting", and the Section entitled "Earthwork" unless otherwise specified.

3.2 DISPOSAL OF DISPLACED MATERIALS

- A. Materials displaced through the use of select fill shall be wasted or disposed of by the Contractor at no additional cost to the Contract.

3.3 SETTLEMENTS

- A. Any settlements in the finished work shall be made good by the Contractor.

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SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes temporary excavation support and protection systems.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Massillon Waste Water Treatment Plant.

1.4 INFORMATIONAL SUBMITTALS

- A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.5 FIELD CONDITIONS

- A. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
 - 1. Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.

PART 3 - EXECUTION

3.1 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.2 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.
- B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.3 TIEBACKS

- A. Drill, install, grout, and tension tiebacks.
- B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
 - 1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.
- C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.4 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.

2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.

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SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 31 20 00 "Earthwork" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
- C. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

1.2 SUMMARY

- A. The Contractor shall provide the labor, tools, equipment, and materials necessary to rehabilitate and/or construct the driveways, parking areas, and walks in accordance with the Plans and as specified herein.

1.3 REFERENCES

- A. ODOT Construction and Materials Specifications, latest edition

1.4 QUALITY ASSURANCE

- A. Pre-installation Conference: Conduct conference at the Massillon Waste Water Treatment Plant prior to beginning the Work.
- B. Perform all work in compliance with all applicable federal, state, and local codes and regulatory agencies.
- C. The paving mix Manufacturer shall be registered with and approved by the Ohio Department of Transportation (ODOT).
- D. Material and work shall be in conformance with all applicable ODOT standards, with the exception of measurement and payment provisions and safety program submittals included in standard specifications which do not apply to this Section.
- E. Engage a testing laboratory acceptable to the Engineer to perform subgrade inspection and compaction tests.

1.5 SUBMITTALS

- A. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:

1. Manufacturer's data on all materials to be used.
2. Submit in writing certifying that all materials and mixes are in conformance with ODOT specifications.
3. Submit all required test data related to the Work of this Section and other related Sections.

1.6 SITE CONDITIONS

- A. Coordinate all pavement installations with proper authorities.
- B. Coordinate pavement installation with other work of Contract such that there is minimum disruption of the completed pavement and/or delays of other work.

1.7 DELIVERY, STORAGE, and HANDLING

- A. DELIVERY
 1. Comply with ODOT Item 401.11.
- B. STORAGE
 1. Comply with ODOT Item 106.05.
- C. HANDLING
 1. Comply with ODOT Item 106.06.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials shall be in accordance with ODOT "Construction Material Specifications" except for method of payment.

2.2 BASES

- A. Aggregate base shall meet the specifications of ODOT Item 304. The use of slag is not permitted.
- B. Asphalt concrete base shall meet the specifications of ODOT Item 301.

2.3 PRIME COAT

- A. Prime coat shall be in accordance with ODOT Item 408.

2.4 TACK COAT

- A. Tack coat shall be in accordance with ODOT Item 407.

2.5 ASPHALT CONCRETE

- A. Asphalt concrete surface course shall be in accordance with ODOT Item 448, Type 1.
- B. Asphalt concrete intermediate course shall be in accordance with ODOT Item 448, Type 2.

2.6 CONCRETE WITH PORTLAND CEMENT

- A. Concrete shall be in accordance with Section 03 33 00 "Cast-in-Place Concrete", Class A, or ODOT Item 451 or 452.

2.7 EXPANSION JOINTS

- A. Expansion joints shall be 1/2-inch thick pre-molded, non-extruding type in conformance with ODOT Item 705.03.

2.8 PARKING BLOCKS

- A. Parking blocks shall be precast concrete, standard curb type, 6" x 8" x 8' with tapered edges and pre-drilled for anchoring. Provide three (3) 3/4" x 16" hot dip galvanized steel anchor pins per unit.

PART 3 - EXECUTION

3.1 GENERAL

A. TOPSOIL

- 1. Topsoil shall be removed. See Section 32 92 00 "Turf and Grasses".

B. SUBGRADE

- 1. Compaction. See Section 31 20 00 "Earthwork".
- 2. All loose and foreign materials shall be removed and the subgrade shall be free of ruts and standing water when the base material is placed.

C. SLOPE

- 1. Driveways, parking areas, and walks shall be sloped to drain away from buildings and structures. Driveways in open areas shall have a center crown. Cross slope for driveways and walks shall be 1/4-inch per foot unless otherwise shown.

D. EXISTING PAVEMENT

1. Driveways, parking areas, and walks shall conform to the grade of existing pavements or walks unless modifications are shown on the Drawings or required by the Specifications.
2. Where it is necessary to disturb existing Portland cement concrete pavements or walks, the concrete shall be saw cut in neat, straight lines. The depth of saw cut shall be at least 2 inches. Where it is necessary to disturb existing asphalt concrete pavements or walks, the asphalt concrete shall be line cut with straight vertical edges by saw cutting. All cut bituminous surfaces shall be sealed with a bituminous material.
3. Existing pavements shall be repaired as shown on the Drawings in conformance with the following ODOT Items:
 - a. Item 251 Partial Depth Pavement Repair
 - b. Item 252 Full Depth Rigid Pavement Removal and Flexible Replacement
 - c. Item 253 Pavement Repair
 - d. Item 254 Pavement Planing
 - e. Item 255 Full Depth Pavement Removal and Rigid Replacement

3.2 PAVEMENT

A. GENERAL

1. All construction shall be in accordance with ODOT "Construction and Material Specifications" latest edition, except for method of payment.

B. ASPHALT CONCRETE DRIVEWAYS AND PARKING AREAS

1. Aggregate base shall consist of compacted aggregate applied in layers of equal thickness to a depth shown on the Drawings in accordance with Item 304.44. No layer shall exceed 6 inches in thickness after compaction. Compaction shall be in accordance with ODOT Item 304.05.
2. Prime coat shall be applied according to ODOT Item 408 at the rate of 0.40 gallon per square yard.
3. Asphalt concrete base shall be installed in two (2) layers. The thickness shall be as shown on the Drawings, after compaction.
4. Unless otherwise shown, wearing surface shall consist of asphalt concrete applied in two (2) layers. Thicknesses of the surface course and the intermediate course shall be as shown on the Drawings, after compaction.

5. Asphalt concrete base and asphalt pavement shall be installed in accordance with ODOT Items 301, 401, and 448.

3.3 CONCRETE WALKS

- A. Concrete walks shall be in conformance with ODOT Item 608, and shall be 4 inches thick, except on driveways which will be 6 inches thick set on a 4-inch compacted aggregate base in conformance with ODOT Item 304.
- B. Concrete shall be float finished with a tooled joint every 4 feet and an expansion joint every 20 feet.

SECTION 32 13 13
CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Driveways.
 - 2. Roadways.
 - 3. Parking lots.
 - 4. Curbs and gutters.
 - 5. Walks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each exposed product and for each color and texture specified.
- C. Other Action Submittals:
 - 1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.4 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. ACI Publications: Comply with ACI 301 unless otherwise indicated.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
- C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- E. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- F. Deformed-Steel Wire: ASTM A 496/A 496M.
- G. Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- H. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.2 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150, gray portland cement Type I. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class C.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 - 2. Blended Hydraulic Cement: ASTM C 595 Type IP, portland-pozzolan cement.
- B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source.
- C. Water: Potable and complying with ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.

- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

2.3 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.5 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

2.6 PAVEMENT MARKINGS

- A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than three.
 - 1. Color: As indicated.
- B. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
 - 1. Color: As indicated.

2.7 WHEEL STOPS

- A. Wheel Stops: Precast, air-entrained concrete or Solid, integrally colored, 96 percent recycled HDPE, or commingled postconsumer and postindustrial recycled rubber or plastic; UV stabilized.
 - 1. Color: Black, Yellow or Gray.
 - 2. Dowels: Galvanized steel, 3/4 inch in diameter, 10-inch minimum length.
 - 3. Adhesive: As recommended by wheel stop manufacturer for application to concrete pavement.

2.8 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), with the following properties:
 - 1. Compressive Strength (28 Days) 4000 psi.
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 - 3. Slump Limit: 3 inch, plus or minus 1 inch.
 - 4. Air Content: 6 percent plus or minus 1.5 percent.
- B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
- C. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
- B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.
- B. Comply with ACI 301 requirements for measuring, mixing, transporting, placing, and consolidating concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed paving surface with a straightedge and strike off.
- E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do

not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
 - 2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 - 3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.
- C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions.
 - 1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
 - 2. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these.

3.8 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot long, unleveled straightedge not to exceed 1/2 inch.
 - 4. Joint Spacing: 3 inches.
 - 5. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 6. Joint Width: Plus 1/8 inch, no minus.

3.9 PAVEMENT MARKING

- A. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.
- B. Sweep and clean surface to eliminate loose material and dust.
- C. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils'

3.10 WHEEL STOPS

- A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.
- B. Securely attach wheel stops to paving with not less than two steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

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SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes chain-link fences and swing gates.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
 - 1. Minimum Post Size: Determine according to ASTM F 1043 for framework up to 6 feet high, and post spacing not to exceed 10 feet for 2 7/8" O.D. Schedule 40 Galvanized steel.
 - 2. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified and on the following:
 - a. Wind Loads: 70 mph.
 - b. Exposure Category: B.
 - c. Fence Height: 6 feet.
 - d. Material Group: IA, ASTM F 1043, Schedule 40 steel pipe

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

- C. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of chain-link fence and gate, from manufacturer.
- B. Product Test Reports: For framing strength according to ASTM F 1043.
- C. Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which Manufacturer and Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
 - 1. Fabric Height: 6'.
 - 2. Steel Wire Fabric: Wire with a diameter of 0.148 inch.
 - a. Mesh Size: 2 inches.
 - b. Steel wire fabric shall be PVC coated.

2.2 FENCE FRAMING

- A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
 - 1. Fence Height: 72 inches.

2. Light Industrial Strength: Material Group IC-L, round steel pipe, electric-resistance-welded pipe.
 - a. Line Post: 2.375 inches in diameter.
 - b. End, Corner and Pull Post: 2.875 inches.
3. Horizontal Framework Members: top rails complying with ASTM F 1043.
4. Brace Rails: Comply with ASTM F 1043.
5. PVC Coating for each product supplied

2.3 TENSION WIRE

- A. Metallic-Coated Steel Wire: 0.177-inch diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:
 1. PVC coated with minimum coating weight matching chain-link fabric coating weight.

2.4 SWING GATES

- A. General: Comply with ASTM F 900 for gate posts and double swing gate types.
 1. Gate Leaf Width: 18 feet.
 2. Gate Fabric Height: 72 inches.
- B. Pipe and Tubing:
 1. PVC-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
 2. Gate Posts: Round tubular steel.
 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded.
- D. Hardware:
 1. Hinges: 180-degree inward swing.
 2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
 3. Padlock and Chain: Owner furnished.
 4. Lock: N/A

5. Closer: Manufacturer's standard.

2.5 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Barbed Wire Arms: Pressed steel or cast iron, with clips, slots, or other means for attaching strands of barbed wire, integral with post cap; for each post unless otherwise indicated, and as follows:
 1. Provide line posts with arms that accommodate top rail or tension wire.
 2. Provide corner arms at fence corner posts.
 3. Type II, single vertical arm.
- C. Finish:
 1. PVC Coated

2.6 BARBED WIRE

- A. Steel Barbed Wire: Comply with ASTM A 121, for two-strand barbed wire, 0.099-inch-diameter line wire with 0.080-inch-diameter, four-point round barbs spaced not more than 5 inches o.c.
 1. PVC Coating

2.7 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by the Engineer.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
- D. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.
- E. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- F. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 3 inches above grade; shape and smooth to shed water.
 - b. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
- G. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
- H. Line Posts: Space line posts uniformly at 10 feet o.c.
- I. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Provide horizontal tension wire at the following locations:
 1. Extended along top and bottom] of fence fabric.
- J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2 inches between finish grade or surface and bottom selvage unless otherwise indicated.
- K. Barbed Wire: Install barbed wire uniformly spaced as indicated on Drawings. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

- L. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.
- M. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

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SECTION 32 92 00

TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Seeding.

1.3 DEFINITIONS

- A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Sediment & Erosion Control Notes & Detail Plan Sheet C-151 for soil preparations and designations for planting soils.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at the Massillon Waste Water Treatment Plant.

1.5 INFORMATIONAL SUBMITTALS

- A. Certification of grass seed.
- B. Product certificates.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

2. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Lawncare Manager.
 - c. Landscape Industry Certified Lawncare Technician.
3. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall store and protect equipment specified herein in accordance with the requirements of Division 01.
- B. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
 1. Quality: State-certified seed of grass species as listed below for solar exposure.
 2. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
 3. Permanent Seeding (March 1- June 15 & August 15-October 15)
Proportioned by weight as follows:
 - a. KY 31 Fescue – 45 #/acre.
 - b. Red Fescue – 20 #/acre.
 - c. KY Bluegrass – 25 #/acre.
 - d. White Dutch Clover – 5 #/acre
 4. Temporary Seeding (June 16-August14 & October 16-March14)
 - a. Summer Temp : Japanese Millet – 30#/acre

- b. Winter Temp: Winter Rye – 170 #/acre

2.2 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: A 10-20-10 ratio of actual nitrogen, phosphorous, and potassium, at a rate determined by soil testing.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium at a rate of 300 #/acre in the following composition:
1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.3 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley at a rate of 2 ton/acre.

2.4 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Sediment & Erosion Control Notes & Detail Plan Sheet C-151
- B. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Engineer's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 95#/acre of permanent seed; 30 #/acre of summer temporary seed; 170 #/acre of winter temporary seed.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

3.3 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
- B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings.

3.4 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by the Engineer:
 - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

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SECTION 33 05 00

TRENCHING, BACKFILLING AND COMPACTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes excavation and backfill as required for pipe installation or other construction in the trench, and removal and disposal of water, in accordance with the applicable provisions Section 31 20 00 "Earthwork" unless modified herein.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.1 EXCAVATION

- A. The trench excavation shall be located as shown on the Contract Drawings or as specified. Under ordinary conditions, excavation shall be by open cut from the ground surface. Where the depth of trench and soil conditions permit, tunneling may be required beneath cross walks, curbs, gutters, pavements, trees, driveways, railroad tracks and other surface structures. No additional compensation will be allowed for such tunneling over the price bid for open cut excavation of equivalent depths below the ground surface unless such tunnel excavation is specifically provided for in the Contract Documents.
- B. Trenches shall be excavated to maintain the depths as shown on the Contract Drawings or as specified for the type of pipe or structure to be installed.
- C. The alignment and depth shall be determined and maintained by the use of a laser beam system. Piping alignments installed utilizing a laser beam system shall be periodically verified utilizing an optical level instrument.
- D. The minimum width of trench excavation shall be 6-inches on each side of the pipe hub for 21-inch diameter pipe and smaller and 12-inches on each side of the pipe hub for 24-inch diameter pipe and larger, unless otherwise shown on the Contact Drawings, specified, or directed.
- E. Trenches shall not be opened for more than 300 feet in advance of pipe installation nor left unfilled for more than 100 feet in the rear of the installed pipe when work is in progress

without the consent of the Engineer. Open trenches shall be protected and barricaded as required.

- F. Bridging across open trenches shall be constructed and maintained where require.

3.2 SUBGRADE PREPARATION FOR PIPE

- A. Where pipe is to be laid on undisturbed bottom of excavated trench, mechanical excavation shall not extend lower than the finished subgrade elevation at any point.
- B. Where pipe is to be laid on special granular material the excavation below subgrade shall be to the depth specified or directed. The excavation below subgrade shall be refilled with special granular material as specified or directed, shall be deposited in layers not to exceed 6-inches and shall be thoroughly compacted prior to the preparation of pipe subgrade.
- C. The subgrade shall be prepared by shaping with hand tools to the contour of the pipe barrel to allow for uniform and continuous bearing and support on solid undisturbed ground or embedment for the entire length of the pipe.
- D. Pipe subgrade preparation shall be performed immediately prior to installing the pipe in the trench. Where bell holes are required they shall be made after the subgrade preparation is complete and shall be only of sufficient length to prevent any part of the bell from becoming in contact with the trench bottom and allowing space for joint assembly.

3.3 STORAGE OF MATERIALS

- A. Traffic shall be maintained at all times in order to maintain Plant operations unless otherwise approved by either Owner or Engineer. The Owner shall be notified by the Contractor, in writing, at least 48 hours prior to any necessary traffic closures.
- B. Place excavated trench materials on the upslope side of trench. Where conditions do not permit storage of materials adjacent to the trench, the material excavated from a length as may be required, shall be removed by the Contractor, at his cost and expense, as soon as excavated and stored on-site in designated stockpiling areas. The material subsequently excavated shall be used to refill the trench where the pipe had been built, provided it be of suitable character. The excess material shall be removed to locations selected and obtained by the Contractor.
 - 1. The Contractor shall, at his cost and expense, bring back adequate amounts of satisfactory excavated materials as may be required to properly refill the trenches.
- C. If directed by the Engineer, the Contractor shall refill trenches with select fill or other suitable materials and excess excavated materials shall be disposed of as spoil.

3.4 REMOVAL OF WATER AND DRAINAGE

- A. The Contractor shall at all times provide and maintain proper and satisfactory means and devices for the removal of all water entering the trench, and shall remove all such water as fast as it may collect, in such manner as shall not interfere with the prosecution of the work.
- B. The removal of water shall be in accordance with Section 31 20 00 "Earthwork".

3.5 PIPE EMBEDMENT

- A. All pipe shall be protected from lateral displacement and possible damage resulting from superimposed backfill loads, impact or unbalanced loading during backfilling operations by being adequately embedded in suitable pipe embedment material. To ensure adequate lateral and vertical stability of the installed pipe during pipe jointing and embedment operations, a sufficient amount of the pipe embedment material to hold the pipe in rigid alignment shall be uniformly deposited and thoroughly compacted on each side, and back of the bell, of each pipe as laid.
- B. Concrete cradle and encasement of the class specified shall be installed where and as shown on the Contract Drawings or ordered by the Engineer. Before any concrete is placed, the pipe shall be securely blocked and braced to prevent movement or flotation. The concrete cradle or encasement shall extend the full width of the trench as excavated unless otherwise authorized by the Engineer. Where concrete is to be placed in a sheeted trench it shall be poured directly against sheeting to be left in place or against a bond-breaker if the sheeting is to be removed.
- C. Embedment materials placed above the centerline of the pipe or above the concrete cradle to a depth of 12-inches above the top of the pipe barrel shall be deposited in such manner as to not damage the pipe. Compaction shall be as required for the type of embedment being installed.

3.6 BACKFILL ABOVE EMBEDMENT

- A. The remaining portion of the pipe trench above the embedment shall be refilled with suitable materials compacted as specified.
 - 1. Where trenches are within a one on one influence of any street or road or within a driveway or sidewalk, or shall be under a structure, the trench shall be refilled in horizontal layers not more than 8 inches in thickness, and compacted to obtain 95% maximum density, and determined as set forth in the Section entitled "Earthwork".
 - 2. Where trenches are in open fields or unimproved areas outside of a one on one influence of roads, the trench shall be refilled in horizontal layers not more than 8 inches in thickness, and compacted to obtain 90% maximum density, and determined as set forth in the Section entitled "Earthwork".
 - 3. Hand tamping shall be required around buried utility lines or other subsurface features that could be damaged by mechanical compaction equipment.
- B. Backfilling of trenches beneath, across or adjacent to drainage ditches and water courses shall be done in such a manner that water will not accumulate in unfilled or partially filled trenches and the backfill shall be protected from surface erosion by adequate means.
 - 1. Where trenches cross waterways, the backfill surface exposed on the bottom and slopes thereof shall be protected by means of stone or concrete rip-rap or pavement.
- C. All settlement of the backfill shall be refilled and compacted as it occurs.

- D. Temporary pavement shall be placed as specified in the Section entitled "Restoration of Surfaces".

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SECTION 33 05 16.13

PRECAST CONCRETE UTILITY STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes valve and meter vaults, catch basins, curb inlets, surface water inlets, and similar structures, complete with frames and covers, manhole steps and appurtenances as shown on the Contract Drawings.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. American Association of State Highway Transportation Officials (ASHTO)

PART 2 - PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

- A. Concrete
 - 1. Cast-in-place concrete for vaults and inlets shall be as specified under the Section entitled "Cast in Place Concrete".
 - 2. Precast concrete sections shall be in accordance with ASTM C478 for manhole sections and ASTM C913 for other structures with a minimum wall thickness of 5 inches. Units and top sections shall be designed and constructed to withstand H-20 wheel loads and shall be of the type shown.
 - a. Bell and spigot joints of precast sections shall have an appropriate "O" ring supplied by the manufacturer, or other types of joints as shown on the Contract Drawings.
- B. Masonry Units
 - 1. Brick shall meet the requirements of ASTM C62, Grade SW, and shall be of a hard-burned manufacture.

2. Concrete blocks shall conform to the requirements of ASTM C139 and shall be solid and of the size shown on the Contract Drawings.

C. Mortar

1. Masonry cement for mortar shall meet the requirements of ASTM C 91, Type II and shall be mixed with a graded quality sand conforming to ASTM C144.
2. Mix shall be one part masonry cement to three parts sand using the minimum amount of clean water required for workability.

D. Castings

1. Frames and covers, grates, inlets, and other castings shall be as shown on the Contract Drawings and be in accordance with ASTM A48, Class 30. All castings shall be manufactured to withstand H-20 wheel loads. Lettering shall be "Storm Sewer" or other appropriate designation cast as directed. Frames and covers shall have machined bearing surfaces.

E. Steps

1. Where shown or specified, steps for vaults and inlets shall be composed of ½-inch Grade 60 ASTM A615 deformed steel reinforcing bar completely encapsulated in copolymer polypropylene plastic, Type PS2-PF as manufactured by M.A. Industries, Inc., or equal.
2. Steps shall be installed in each vault or inlet in vertical alignment spaced 12 inches on center and shall be placed over the largest benchwall of the manhole.
3. Steps shall have a minimum tread width of 12 inches and shall be cast into the vault sections or other methods of installation with prior acceptance of the Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Precast Sections

1. Precast sections shall be installed on a flat stable subgrade with select fill as shown in contract documents and geogrid.
2. Prior to installation of granular material for precast manhole bases, contractor shall prepare flat, stable subgrade. Where an unstable condition exists, the Contractor shall excavate the unstable material and replace with compacted granular material as specified.
3. All joints shall be filled inside and out with mortar to provide a smooth and continuous surface.

B. Benchwalls and Inverts

1. Mortar surfaces of benchwalls and concrete floors shall be given a broom finish. Where inverts are required they shall be lined with a half section of pipe of the same type used for the sewer or shall be constructed of Class "C" concrete, shaped and troweled to produce a smooth circular cross-section.

C. Frames and Castings

1. Frames and castings shall be set in a full bed of mortar a maximum of 1/2" thick. Where required to adjust the frames and castings to grade there shall be installed to a maximum of four brick courses.

D. Steps

1. Steps shall be installed in vertical alignment spaced 12 inches on center.
2. In concrete sections the steps shall be cast into the section or secured with cadmium plated bolts to threaded inserts which are precast into the concrete.
3. In masonry construction the steps shall be built into the masonry walls.

E. Plastering

1. Plaster shall be with mortar not less than 1/2 inch thick and troweled smooth.
2. Outside of masonry structures.
3. Inside and outside of brick courses under frames and castings.

F. Sumps

1. Sumps of the size specified shall be built into the floors of vaults and similar structures. Floors shall be sloped to the sump.

3.2 FIELD TESTING

- A. For hydraulic structures, perform leakage tests in accordance with the applicable provisions of the Section entitled "Leakage Tests for Concrete Hydraulic Structures".

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SECTION 33 05 28

TRENCHING AND BACKFILLING FOR UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SECTIONS INCLUDES

- A. This Section includes the following:
 - 1. Bedding and Backfilling materials.
 - 2. Staking and Grades
 - 3. Existing Utilities
 - 4. Trenching and Utilities
 - 5. Bedding and Backfilling
 - 6. Field Quality Control
 - 7. Metal supports and anchorages.

1.3 RELATED SECTIONS

- A. Dewatering is specified in Section 31 23 19 – Dewatering
- B. Excavation support systems are specified 31 50 00 – Excavation Support and Protection.
- C. Earthwork is specified in 31 20 00 – Earthwork. The work of this Section shall confirm with the requirements of Section 31 20 00 – Earthwork, as applicable.

1.4 MEASUREMENT AND PAYMENT

- A. Measurement: Trenching and Backfilling for Utilities will not be measured separately for payment.
- B. Payment: Trenching and Backfilling for Utilities will be paid for as part of the indicated Contract unit prices for the associated piping, conduits, ductbanks, and utility structures.

1.5 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM C33 Specification for Concrete Aggregates

1.6 DESCRIPTION

- A. This Section includes specifications for excavating, trenching, and backfilling for utilities and related structures, as indicated, including underground piping for water supply, sanitary and storm sewerage piping; trackway and roadway site subsurface and drainage piping; underground electrical conduits and ductbanks; and utility boxes, catch basins, manholes, inlets pull boxes, and vaults.
 - 1. Trenching and Backfilling for utilities includes restoration of existing pavements, where applicable, to the conditions existing before the excavation. Conform with applicable requirements of Section 32 12 16 – Asphalt Paving, Section 32 13 13 – Concrete Paving and Section 32 16 21 – Concrete Curbs, Gutters, and Walks.

1.7 REGULATORY REQUIREMENTS

- A. Regulatory requirements that govern the work of this Section include the following governing codes:
 - 1. OSHA
 - 2. City of Massillon

1.8 SUBMITTALS

- A. Refer to Division 01 Specifications for submittal requirements and procedures. r trenches of 5 feet or more in depth shall be submitted to the Engineer for review and approval.
- B. Submit drawings and supporting calculations for trench excavations and support systems of 5 feet or more in depth in accordance with the submittals requirements of Section 31 50 00 – Excavation Support and Protection. All such submittals shall be prepared, sealed and signed by a professional civil or structural engineer.

PART 2 - PRODUCTS

2.1 BEDDING AND BACKFILL

- A. Bedding:
 - 1. Sand: Sand for bedding of pipe in utility trenches shall be a clean and graded, washed sand, all passing a No. 4 U.S. Standard sieve, and conforming generally to ASTM C33 for fine aggregate. A finer sand may be used, if convenient, provided the sand is clean and does not contain deleterious substances in excess of the amount specified in ASM C33, Table 3.
 - a. Only sand will be permitted for bedding of concrete pipe, clay pipe, and cast-iron pipe.

2. Pea Gravel: Clean and graded, washed river-run gravel, ASTM C33, Size No. 7. Pea gravel may be used in trenches requiring additional drainage and for backfilling above the pipe's upper half (above the horizontal centerline).
- B. Backfill Material: Backfill for excavations and trenches under structures and paving shall be Structural Fill as indicated. (Refer to Section 31 20 00 – Earthwork, for requirements.) Common Fill will be permitted only for backfilling of excavations and trenches in open areas and landscaped areas.
- C. Filter Fabric: Geotextile engineering fabric conforming to ODOT Construction and Materials Specifications Section 712.09, Filter Fabric for underdrains.

PART 3 - EXECUTION

- 3.1 STAKING AND GRADES: Refer to Section 31 20 00 – Earthwork, for requirements.
- 3.2 EXISTING UTILITIES: Refer to Section 33 05 25 – Support and Protection of Utilities, and Section 31 00 00 – Earthwork, for requirements.
- 3.3 TRENCHING AND EXCAVATING
 - A. Perform trenching and excavating as indicated and required for drainage and utility piping, conduits, and related structures, and provide shoring, bracing, pumping, and planking as required and as specified in Section 31 50 00 – Excavation Support and Protection.
 - B. Excavate to the lines and grades indicated.
 - C. Excavate trenches for pipes and conduits by the open-cut method, except where tunneling or jacking are indicated. Hand-excavate for crossing pipelines.
 - D. In paved areas, cut pavement on the neat lines at the width indicated for the trench. Pavement shall be saw cut. After compacting the backfill, restore pavement to a condition equivalent to that existing at the start of construction. Restore pavement damaged outside the neat lines.
 - E. Excavate trenches to the indicated width at all points below a horizontal plane 2 feet above the top of the pipe. Excavation above this plane may exceed the indicated width as required. Where the width is not indicated, make the width not less than 6 inches or more than 18 inches from the outside of the pipe. If the excavation exceeds permissible dimensions, install higher strength pipe or encase the pipe in Class 3000 concrete.
 - F. The bottoms of excavations shall be firm, undisturbed earth or cut sub grade, clean and free from loose material, debris, and foreign matter. When bottoms of excavations or trenches are a soft or unstable material, the bid shall be made firm and solid by removing said unstable material to a sufficient depth and replacing same with sand or pea gravel, compacted to a least 90 percent relative compaction.

- G. Where water is encountered in the trench, dewater as specified in Section 31 23 19 – Dewatering, and provide sand or pea gravel as required to drain the water and stabilize the bed.
- H. Bell holes shall be accurately placed and shall not be larger than required to make the joint.
- I. Excavations for structures shall conform to applicable requirements of Section 31 20 00 – Earthwork.

3.4 BEDDING AND BACKFILLING

- A. Material for bedding of pipe shall be sand. Minimum thickness of sand bedding under concrete, clay, and cast-iron pipe shall be 2 inches. Provide firm and uniform support of piping at indicated elevations and grades. Tamp sand bedding as required for firm support.
 - 1. The joints of gravity flow piping shall be wrapped with filter fabric all around the pipe. Place filter fabric under the pipe before laying pipe in sand bedding. Filter fabric shall extend at least 12 inches on each side of joint.
- B. Backfill below the horizontal centerline of pipe shall be sand. Backfill to 6 inches above the top of pipe from the horizontal centerline of pipe shall be the material herein specified in Articles 2.01.A.2 and 2.01.B, as applicable.
- C. Backfill shall be placed in 6-inch layers, leveled, rammed and tamped in place. Each layer shall be compacted with suitable compaction equipment to a least 90 percent relative compaction, taking care not to damage or misalign any pipe. The top 12 inches under structures and pavement shall be compacted to a least 95 percent relative compaction.
- D. Backfilling around concrete structures and for ductbanks and similar utilities shall conform to the applicable requirements of Section 31 20 00 – Earthwork.

3.5 FIELD QUALITY CONTROL:

- A. Comply with applicable requirements specified in Section 31 20 00 – Earthwork.

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SECTION 33 08 30.11

LEAKAGE TESTS – NON-STRUCTURAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for testing of pressure and nonpressure piping for leakage as specified.
 - 1. The Contractor shall furnish labor, equipment, test connections, vents, water and materials necessary for carrying out the pressure and leakage tests.
 - 2. Refer to Section entitled “Pipe Pressure Tests” for testing of interior piping.
- B. Testing shall be witnessed by the Engineer, and/or Owner at their request.

1.3 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions and Division 01, the following items shall be submitted:
 - 1. Reports of test results.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.1 TESTS ON PRESSURE PIPING FOR TRANSPORT OF WATER OR SEWAGE

- A. General
 - 1. Contractor shall backfill all buried piping to finish grade prior to testing.
 - 2. Pipelines designed to transport water or sewage under pressure shall be tested hydrostatically and for leakage prior to being placed in service.
 - 3. The length of piping and sections included in the tests shall meet the approval of the Engineer.

4. Equipment in or attached to the pipes being tested shall be protected. Any damage to such equipment during the test shall be repaired by the Contractor at his expense.
5. When piping is to be insulated or concealed in a structure, tests shall be made before the pipe is covered.
6. All fittings, hydrants and appurtenances must be properly braced and harnessed before the pressure is applied. Thrust restraining devices which will become a part of the system must also be tested at the test pressure.
7. When testing absorbent pipe materials such as asbestos cement, cement lined or concrete, the pipeline shall be filled with water at least twenty-four (24) hours before the test is made.
8. If the line fails the tests specified herein, the Contractor shall explore for the cause of the excessive leakage and after repairs have been made the line shall be retested. This procedure shall be repeated until the pipe complies.

B. Pressure Test

1. Test pressure for low pressure process yard piping shall be 15 psi, unless otherwise noted. "Low Pressure" shall mean gravity pipe flow conditions for which the design hydraulic grade line is above the pipe crown, i.e. typically process piping running between process tanks.
2. Gravity plant drains and storm drains shall be tested in accordance with the requirements for "Test for Non-Pressure Pipelines for Transport of Water and Sewage" as included herein.
3. Test pressure for all piping used for force mains, the utility water system and the potable water system shall be twice the system working pressure or 150 psi, whichever is less.
4. Test pressure shall be held on the piping for a period of at least 2 hours, unless a longer period is requested by the Engineer.

C. Leakage Test

1. The leakage test shall be conducted concurrently with the pressure test.
2. The rate of leakage shall be determined at 15 minute intervals by means of volumetric measurement of the makeup water added to maintain the test pressure. The test shall proceed until the rate of leakage has stabilized or is decreasing below an allowable value, for three consecutive 15 minute intervals. After this, the test pressure shall be maintained for at least another 15 minutes.
 - a. At the completion of the test the pressure shall be released at the furthestmost point from the point of application.

3. All exposed piping shall be examined during the test and all leaks, defective material or joints shall be repaired or replaced before repeating the tests.
4. The allowable leakage for pressure pipelines shall not exceed the following in gallons per twenty-four (24) hours per inch of diameter per mile of pipe:

<u>Type of Pipe</u>	<u>Leakage</u>
Ductile iron	10
Polyvinyl chloride, thermal plastic or fiberglass with rubber joints	10
Polyvinyl chloride, thermal plastic, HDPE (thermal heat fusion joints) or fiberglass with solvent-cemented joints	0
Concrete with steel and rubber joints	10
Steel with welded joints	0
Steel with harnessed joints	10
Wrought steel	0
Copper	0
All piping inside structures	0

5. Regardless of the above allowables, any visible leaks shall be permanently stopped.

3.2 TEST FOR NON-PRESSURE PIPELINES FOR TRANSPORT OF WATER OR SEWAGE

A. General

1. Contractor shall backfill all buried piping to finish grade prior to testing.
2. Pipelines designed to carry water or sewage in open channel flow or at minimal pressures shall be tested for leakage prior to being placed in service.
3. The leakage shall be determined by low pressure air.
 - a. The maximum non-pressure pipeline to be tested for leakage shall be the section between manholes or 600 feet as directed by the Engineer.
4. Intermediate leakage tests during construction shall be made at the Contractor's discretion. Upon completion of any pipeline, the entire system including manholes shall be tested for compliance to allowable leakage.
5. If the line fails the test, the Contractor shall explore for the cause of the excessive leakage and after repairs have been made the line shall be retested. This procedure shall be repeated until the pipe complies.

B. Air Testing

1. Air testing for acceptance shall not be performed until the backfilling has been completed.
2. Low pressure air tests shall conform to ASTM C 828 except as specified herein and shall not be limited to type or size of pipe.
3. All sections of pipelines shall be cleaned and flushed prior to testing.
4. The air test shall be based on the average holding pressure of 3 psi gauge, a drop from 3.5 to 2.5 psi, within the period of time allowed for the size of pipe and the length of the test section. The time allowed for the 1 psi drop in pressure, measured in seconds, will be computed by the Engineer and will be based on the limits of ASTM C 828.
 - a. When groundwater is present the average test pressure of 3 psig shall be above any back pressure due to the groundwater level.
 - b. The maximum pressure allowed under any condition in air testing shall be 10 psig. The maximum groundwater level for air testing is 13 feet above the top of the pipe.
5. The equipment required for air testing shall be furnished by the Contractor and shall include the necessary compressor, valves and gauges to allow for the monitoring of the pressure, release of pressure and a separable test gauge.
 - a. The test gauge shall be sized to allow for the measuring of the one psig loss allowed during the test period and shall be on a separate line to the test section.

3.3 MANHOLE TESTING

- A. Testing shall be done by vacuum testing as based on ASTM C 1244. Any visible leakage or seepage shall be repaired by the contractor.
- B. Testing shall be done prior to backfilling manholes.
- C. All pipes entering manhole shall be plugged and braced.
- D. In conditions where groundwater is present and it produces a hydrostatic head of 12-feet or greater above the invert of the manhole, the vacuum pressure shall be adjusted as follows:
 1. The pressure in Hg shall be reduced by 1 Hg for every 1-foot of hydrostatic head from 12 to 22-feet above the invert of the manhole.
- E. A vacuum of 10 inches of mercury shall be drawn on the manhole, the time shall be measured for the vacuum to drop from 10 to 9-inches of mercury. This time shall meet or exceed the Table located in ASTM 1244 for the manhole to pass the test.

3.4 AIR, OIL AND GAS PIPING

- A. All pipelines for air, oil and gas shall be cleaned and tested with air at the pressure specified and no leakage will be allowed. After these tests are complete, fuel gas lines shall be flushed out with nitrogen or carbon dioxide before fuel gas is admitted.

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SECTION 33 13 00

CHLORINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the cleaning, chlorinating and flushing of all pipelines or structures which shall carry or hold potable water, as shown on the Contract Drawings, including all chemicals required.
- B. For chlorination requirements of indoor plumbing related piping, refer to the Section 22 11 16 "Domestic Water Piping".

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Water Works Association (AWWA)

1.4 USE OF WATER

- A. Permission shall be obtained from the Owner of the water system before the use of water from any existing system. The Contractor shall:
 - 1. Conform to the requirements of the Owner.
 - 2. Pay all costs connected with the taking or use of water.
 - 3. Give notice at least 24 hours before the use of water for any reason.
- B. All work under this section shall be performed in the presence of the Engineer and a representative of the public health authority having jurisdiction, as required.
- C. Chlorination shall be scheduled such that sampling and flushing will be performed during normal daylight working hours.

1.5 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions and Division 01, the following items shall be submitted:

1. Material Safety and Data Sheets for all chemicals to be used.

PART 2 - PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

- A. Chlorination shall be by the use of a solution of water and liquid chlorine, calcium hypochlorite or sodium hypochlorite and the solution shall be contained in the pipe or structure as specified.
- B. Chlorine, calcium hypochlorite, or sodium hypochlorite shall be made-up prior to injecting into the piping to be tested. Under no circumstances shall chlorination of lines be accomplished by placing tablets in the line to dissolve when line is filled.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Prior to chlorination all cuttings, oil, dirt and foreign matter shall be removed by a thorough cleaning and flushing of the pipeline or structure.
- B. The chlorine solution shall be admitted to pipelines through corporation stops placed in the horizontal axis of the pipe, to structures by means of tubing extending directly into the structure or other approved methods.
- C. The application of the chlorine solution shall be by means of a solution feed device or the continuous feed method. The rate of chlorine solution flow shall be in such proportion to the rate of water entering the pipe or structure that the resulting free chlorine residual shall not be less than 100 parts per million (PPM), milligrams per liter (mg/l).
- D. The slug method may be used for chlorination of pipelines with the prior approval of the Engineer and shall be in accordance with AWWA C651, Section 5.3.
- E. The chlorine treated water shall be retained in the pipe or structure at least 24 hours, unless otherwise directed. During the retention period all valves and hydrants within the treated sections shall be operated.
- F. The chlorine residual shall be not less than 25 PPM (mg/l) at any point in the pipe or structure at the end of the retention period.
- G. When making repairs to or when specified, structures and portions of pipelines shall be chlorinated by a concentrated chlorine solution containing not less than 200 PPM (mg/l) of free chlorine. The solution shall be applied with a brush or sprayed on the entire inner surface of the empty pipes or structures. The surfaces disinfected shall remain in contact with the strong chlorine solution for at least 30 minutes.

3.2 FLUSHING

- A. After the required retention of chlorinated water in the pipe or structures they shall be thoroughly flushed until the replacement water shall, upon test, both chemically and bacteriologically, be proven equal to the water quality served by the public from the existing water supply system.
- B. The disposal of chlorinated water from any pipe or structure shall be such that it will not cause damage to any vegetation, fish, or animal life and shall be in accordance with any requirements stated in the Special Provisions.

3.3 FIELD TESTING

- A. The Contractor shall make all arrangements for the testing of water quality. In areas where the testing of water quality is not performed by the public health authority, the Contractor shall have the required test made by an approved independent laboratory. The results of all tests shall be forwarded to the Engineer and the public health authority having jurisdiction. The results of these samples must indicate no coliform contamination. If contamination is indicated, then the disinfection procedure must be repeated.
- B. The Contractor shall provide the men and tools as may be required by the Engineer or the public health authority in the sampling for testing of water quality.
- C. The chlorination procedure and final tests shall be carried out under the supervision of the Owner or Engineer. Two consecutive satisfactory bacteriological samples must be obtained from the distribution system. Twenty-four hours apart, all valves and appurtenances must be operated, and the tests shall be conducted on each 1000 feet of the distribution system. Final approval will be given when satisfactory results are reported to the public health authority having jurisdiction and final field inspection is satisfactory.
- D. All water quality requirements shall be fulfilled prior to the passage of any water through the new system to a public supply or the use of the new system.

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SECTION 33 41 00

STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Channel drainage systems..
 - 3. Manholes.
 - 4. Nonpressure transition couplings.
 - 5. Expansion joints.
 - 6. Catch basins.
 - 7. Stormwater inlets.
 - 8. Pipe outlets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Manholes: Include plans, elevations, sections, details, frames, and covers.
 - 2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet.

Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

- C. Product Certificates: For each type of cast iron soil pipe and fittings from Manufacturer.
- D. Field quality-control reports.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Construction Manager's or Owner's written permission.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

- A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
 - 2. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
- B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
 - 2. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.2 CONCRETE PIPE AND FITTINGS

- A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.
 - 1. Bell-and-spigot ends and gasketed joints with ASTM C 443, rubber gaskets or sealant joints with ASTM C 990, bitumen or butyl-rubber sealant
 - 2. Class IV

2.3 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers: Frames and covers shall be provided in accordance with The City of Massillon Project Specifications, SANITARY & STORM MANHOLES & CATCH BASINS - Section 14 of which can be found at <http://www.massillonohio.com/engineering/standard.htm>

2.4 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 1 percent through manhole.
 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.5 CATCH BASINS

- A. Standard Precast Concrete Catch Basins:
1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.

4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
 6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
 7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and grate.
 8. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches.
 9. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- B. Manhole Frames and Covers: Frames and covers shall be provided in accordance with The City of Massillon Project Specifications, SANITARY & STORM MANHOLES & CATCH BASINS - Section 14 of which can be found at <http://www.massillonohio.com/engineering/standard.htm>

2.6 STORMWATER INLETS

- A. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.
- B. Frames and Grates: Heavy duty [according to utility standards].

2.7 PIPE OUTLETS

- A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
- B. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to ODOT Construction and Materials Specifications, Latest Edition.
 1. Average Size: Recommended d50= 6 inches.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 31 20 00 "Earthwork."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
 - 3. Install piping with planned minimum cover.
 - 4. Install PE corrugated sewer piping according to ASTM D 2321.
 - 5. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
 - 2. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
 - 3. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.

- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.5 CATCH BASIN INSTALLATION

- A. Set frames and grates to elevations indicated.

3.6 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipaters at outlets, as indicated.

3.7 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.8 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."
- B. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering

connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

- a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- C. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."
- D. Pipe couplings and expansion joints with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Unshielded flexible couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.9 IDENTIFICATION

- A. Materials and their installation are specified in Section 31 20 00 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
1. Use warning tape or detectable warning tape over ferrous piping.
 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.10 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soil-tight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.
 - c. Option: Test concrete piping according to ASTM C 924.

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- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

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SECTION 33 41 33

MANHOLES –SANITARY SEWER

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

A. Work Included

- 1. Pre-Cast Concrete Manholes
- 2. Drop Connections
- 3. Clean-Outs

B. Related Work Specified Elsewhere

1. Submittals	Section 00 13 00
2. Testing Sewer Systems	Section 33 38 00
3. Earthwork	Section 31 20 00
4. Trench Excavation and Backfill for Sewer Lines	Section 33 05 00

1.3 QUALITY ASSURANCE

- A. Manholes shall be constructed to allow less than 50 gallons/day of infiltration.

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 00 13 00:

- 1. Shop Drawings
 - a. Precast Manhole Sections
 - b. Frames and Covers
 - c. Steps
- 2. Materials Certification

- a. Precast Manhole Sections
- b. Frames and Covers
- c. Steps
- d. Bitumastic Paint

PART 2 – PRODUCTS

2.1 MATERIALS

A. Material Standards

- 1. Manholes shall comply with the City of Massillon Project Specifications.

B. Material Sources

- 1. Cast Iron Frames and Covers shall comply with the City of Massillon Project Specifications.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Excavation shall be made in accordance with Section 31 20 00.

B. Precast bottom section shall be installed on 6 inches of bedding material, per Section 33 41 00.

Note – If Contractor elects to not use a precast bottom section, the following shall apply:

- 1. First section shall be blocked up using concrete block.
- 2. Concrete base shall be placed using ready-mix concrete with Type 1 Portland cement concrete.
- 3. Base shall be allowed to set for 48 hours prior to proceeding.

C. Precast manhole section shall be added to the bottom section using care to ensure that O-ring joints are set properly. Steps shall be carefully aligned during erection of manhole. If steps are missing or broken, they shall be mortared in place after erection. Finished manhole shall have steps spaced 12 inches (30 cm) on center.

D. After all sections are erected, joints shall be trowelled with mortar on both sides.

- E. Short sections of brick masonry (maximum 3 courses) shall be used to bring the manhole to grade. The following shall apply:
 - 1. Sewer brick shall be clean and thoroughly wetted.
 - 2. Brick shall be laid in a full bed of mortar in a radical pattern.
 - 3. After the initial set, the inside and outside surfaces shall be plastered and trowelled smooth. Minimum thickness shall be ½ inch (13 mm).
 - 4. After final set, plastered surfaces shall be coated with bitumastic paint.
- F. Manhole frames shall be set in a full bed of mortar. Bed of mortar shall also completely cover and enclose the frame flange.
- G. Adjustable manhole frames shall be set in a full bed of mortar. Care shall be taken to set frame in direction of grade to allow for adjustment to final paving grade.
- H. Sewer pipe connection to manhole shall utilize a rubber sleeve cast integrally into the manhole section, or a rubber sleeve attached to the pipe. After gasket connection is made, the joint shall be filled and enclosed with expanding, waterproofing cement grout.
- I. After connection and grouting of sewer pipes, the joint shall be coated with bitumastic paint.
- J. Stub pipes shall be installed where shown on the Contract Drawings or as directed in the field by the ENGINEER. All stub pipes, which are not immediately used, shall be plugged with a standard sewer plug.
- K. Drop connections shall be installed where shown and as specified in the Contract Drawings
- L. The invert shall be placed, formed, shaped and finished as detailed in the Contract Drawings
- M. Manhole excavation shall be backfilled as per Section 31 20 00.
- N. Cleanouts shall be installed where shown and as detailed on the Contract Drawings; or as directed by the ENGINEER.
- O. When the removal of existing manholes or other structures are required, the contractor shall remove the debris from the job site and dispose of it properly.
- P. The installation of the manhole over the existing line shall be accomplished by carefully excavating around the line on both sides under the pipe. A “doghouse” section of manhole riser shall be lowered into place and supported on stone bedding. Concrete shall be placed to a depth of one-half the diameter of the existing pipe on the inside and one-third outside of the vertical manhole section. After the concrete is set, the top of the existing pipe shall be removed and shaped to receive sewage from the new line. After the

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new line is installed, the invert shall be finished to channel sewage from new line to the old line.

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SECTION 35 20 16.1

STAINLESS STEEL HYDRAULIC GATES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes stainless steel gates, including sluice, slide and weir gates, complete with all appurtenances, as indicated in accordance with the Contract Documents.

1.3 RELATED SECTIONS

- A. Related Sections include the following:
 - a. Division 9
 - i. "Painting"
 - b. Division 40
 - i. "Electrically Operated Primary Control Valves"

1.4 QUALITY ASSURANCE

- A. Gates shall be the product of a single manufacturer.
- B. All materials furnished under this Section shall be furnished by manufacturers who have at least five years experience in the design, production, assembly, and field service of units of like type, size, and materials.
- C. References

Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

- 1. American National Standards Institute (ANSI)
 - 2. American Water Works Association (AWWA)
 - 3. American Welding Society (AWS)
 - 4. American Society for Testing and Materials (ASTM)
- D. Welding shall be performed in accordance with AWS standards or ASME Section IX.
- E. Gates and operators shall be furnished with all necessary parts and accessories; and shall be fabricated, assembled and placed in proper operating condition in

accordance with installation instructions and recommendations of the equipment manufacturer.

1.5 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification are identified as provided below in Section 2.6 SCHEDULE.

1.6 SUBMITTALS

A. Shop Drawings

1. In addition to those submittals identified elsewhere, the following items shall also be submitted in accordance with the General and Supplementary Conditions and Division 01:
 - a. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.
 - b. Shop drawings, including dimensions, material of construction, size and location of connections to other work, and weight of equipment.
 - c. Catalog information and cuts.
 - d. Complete manufacturer's specifications, including materials description and lubricant requirements.
 - e. Suggested spare parts list with current price information.
 - f. List of special tools required for checking, testing, parts replacement, and maintenance. Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.
 - g. List of special tools furnished with the equipment.
 - h. Special handling instructions.
 - i. Requirements for storage and protection prior to installation.
 - j. Manufacturer's installation recommendations.
 - k. Requirements for routine maintenance required prior to startup.

1. Submit a coordination list that identifies each gate. The coordination list shall include project specific information such as tag numbers, gate type, size, and application.
2. Motor-Operated Gates
 - a. Submittals for motor-operated gates shall include electric actuator information as specified in the Submittals section of the specification entitled "Electrically-Operated Primary Control Valves". Submittal of the electric actuator shop drawings under a separate cover shall not be permitted.
 - b. The gate manufacturer shall submit written certification with the submittal of motor-operated gates that:
 - (1) The electric actuator supplied with the gate has been coordinated with the gate operating requirements.
 - (2) The gate manufacturer has reviewed the electric actuator shop drawings, and the shop drawings have been coordinated with the gates so as to provide a completely functional and operational system.
- B. Submit Operation and Maintenance Manuals for the gates in accordance the General and Supplementary Conditions and Division 01.
- C. Submit Manufacturer's Certificate of proper installation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Materials and equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Such boxes, crates or protection shall be clearly labeled with manufacturer's name, brand or model designation, type or grade and color.
- B. Protect materials and equipment from exposure to the elements and keep dry at all times. Handle and store to prevent damage in accordance with manufacturer's recommendations.
- C. Material and equipment damaged by handling and storage shall be repaired or replaced by the Contractor as directed by the Engineer.

1.8 WARRANTY

- A. Gates and appurtenances shall be provided with manufacturer's warranty of not less than one (1) year from date of final acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are as follows:

1. Fontaine (Sluice – Series 20, Slide – Series 25, Weir – Series 40)
2. WACO Products Inc. (Series 7500)
3. Whipps, Inc (Series 900)
4. Or approved equal

2.2 GENERAL

- A. Furnish and install stainless steel gates with frames and accessories suitable for high humidity and corrosive conditions.
- B. Stainless steel gates shall be suitable for service in raw sewage.
- C. Gate assemblies shall be designed for mounting as indicated in the gate schedule.

2.3 PERFORMANCE REQUIREMENTS

- A. Gates shall be designed for the indicated seating and unseating heads.
- B. Gates shall conform to the requirements of AWWA C561, applicable to discs and frames with a safety factor of 5 with regard to tensile, compressive and shear strength.
- C. All gates shall meet the allowable leakage specified herein according to gate type.
- D. Materials of construction shall be suitable for the environment.
- E. Sluice Gates
1. Gates shall be substantially watertight under the design head conditions. Under the design head, seating or unseating, as specified, the leakage shall not exceed 0.1 U.S. gallon per minute per foot (1.24 l/min per meter) of seating perimeter.
 2. The sluice gates shall be designed to withstand the design head shown in the schedule.
 3. The gate's sealing system should have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.
- F. Slide Gate

1. Gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.10 U.S. gallon per minute per foot seal periphery under the design seating head and unseating head.
2. The slide gates shall be designed to withstand the maximum design head (maximum design head shall be taken as the height of the slide unless otherwise shown in the schedule).
3. The gate's sealing system should have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.

G. Weir Gates

1. Gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.10 U.S. gallon per minute per foot seal periphery under the design seating head and unseating head.
2. The weir gates shall be designed to withstand the maximum design head (maximum design head shall be taken as the height of the slide unless otherwise shown in the schedule).
3. The gate's sealing system should have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.

2.4 MATERIALS AND CONSTRUCTION

A. Frames shall be 316L stainless steel.

B. Sluice Gates

1. Gates shall be either self-contained or non self-contained of the rising stem, non-rising or telescopic stem configuration as indicated on the gate schedule.
2. The wall thimble shall be stainless steel and supplied by the gate manufacturer. Refer to the gate schedule for type and applicable locations. Material thickness should be 1/4-inch minimum material thickness in accordance with AWWA C561.
3. The gate frame shall be constructed of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be of the flange back design suitable for mounting on a concrete wall (CW), concrete wall with extra-wide flange (CWX), round manhole (RM), round manhole with extra-wide flange (RMX), a wall thimble (WT), or a standard flange (SF). The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene).
4. The frame configuration shall be of the flush-bottom type and shall allow the replacement of all seats and all seals without removing the gate frame from the concrete or wall thimble.

5. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to $1/720$ of the gate's span under the design head.
6. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds ($2/3$) of the vertical height of the slide in the fully open position.
7. Side and top seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate.
8. The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.

C. Slide Gates

1. Gates shall be either self-contained or non self-contained of the rising stem, non-rising or telescopic stem configuration as indicated on the gate schedule.
2. The gate frame shall be constructed of structural members or formed plate. The frame shall be suitable for mounting on a concrete wall (CW) at the end of a channel, embedded inside a channel (FE) or mounted on the channel surface (EC). The guide slot shall be of UHMWPE (ultra high molecular weight polyethylene). The frame configuration shall be of the flush-bottom type.
3. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to $1/720$ of the gate's span under the design head.
4. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds ($2/3$) of the vertical height of the slide in the fully open position.
5. Side and top seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate.
6. Seals shall maintain the specified leakage rate in both seating and unseating conditions. The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.

D. Weir Gates

1. Gates shall be either self-contained or non self-contained of the rising stem, non-rising or telescopic stem configuration as indicated on the gate schedule.
2. The gate frame shall be constructed of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be of the flange back design, suitable for mounting on a concrete wall (CW). The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene).
3. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head.
4. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.
5. The bottom and side seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open part of the gate.
6. Seals shall maintain the specified leakage rate in both seating and unseating conditions.

E. Stems

1. Stems and extensions shall be entirely of Type 316 Stainless steel. Stems shall have a minimum diameter of 1-1/2 inches.
2. All stems to have clear acrylic covers.
3. Gates 72" and larger shall have a dual stem configuration.
4. The sections of extension stems shall be joined together by solid couplings, threaded and keyed to the stems. All couplings of the same size shall be interchangeable.
5. Stems shall be furnished with adjustable, bronze or UHMWPE bushed stem guides, spaced as necessary to maintain a slenderness ratio L/R of less than 200.
6. Stems shall be of ample cross section to prevent distortion and shall have stub acme threads.
7. Stems shall be designed to withstand tensile and compressive loads that occur under maximum operating conditions. Design for compressive loading shall meet AISC code where K=1 with a minimum safety factor of 2 to 1.

8. Stems shall be cold rolled with a double start stub acme thread and a finish of 32 microns or less.
9. Stem shall be fixed to the disc by a threaded and keyed assembly into a lifting nut, attached to the disc in a lifting bracket which is bolted to the disc.
10. Gates and stems shall be threaded for opening in direction scheduled herein.

2.5 ACCESSORIES

A. Manual Gate Operators

1. Gates shall be provided with manual operators of the right-angle geared crank type with drill nut attachment. Operators shall be rising-stem with clear plastic cover with graduated gate position indicators.
2. Provide gearing as necessary to coordinate manual operator with space available at gate installation location.
3. Operators shall be sized to start the gate moving under maximum head pressure with a pull of not more than 40 pounds.
4. Provide indication of "OPEN" and arrow indicating direction of operator rotation to open gate.
5. The lifting mechanism shall be capable of withstanding, without damage, an effort of up to 200 pounds.
6. Provide manual operator with anti-friction brass or roller bearings.
7. Provide lubrication fittings for grease lubrication of bearings.
8. Provide floor stand for gate operators for open-frame gates. All floor stands and wall bracket shall be fabricated from 316L stainless steel. Aluminum is not an acceptable material.

B. Motor Operators

1. Motorized gate operators and positioners shall meet applicable requirements of the Section entitled "Electrically-Operated Primary Control Valves".

C. Anchor Bolts and Hardware

1. All necessary attaching bolts, anchor bolts, mounting and assembly hardware shall be of Type 316 stainless steel and shall be furnished by the gate manufacturer.

2.6 SCHEDULE

- A. Provide stainless steel gates as indicated in the Contract Documents and scheduled below. Operators are motor powered or manual handwheel as noted in the schedule.

<u>Tag No.</u>	<u>Style</u>	<u>Description</u>	<u>Gate Frame Mounting</u>	<u>Opening Direction</u>	<u>Dimensions W x H/Dia.</u>	<u>Operator Mounting</u>	<u>Head Conditions</u>
<u>"Chapman Valve"</u>							
	Sluice Gate	Influent Gate	Non Self-Contained, CW	Up	66" x 66"	Floor Stand, Motor Operator, Rising Stem	17' Seating, 10' Unseating
<u>Influent Screw Pumps</u>							
	Slide Gate	Influent Screw Pump No. 1 Isolation	Non Self-Contained, CW	Up	42" x 42"	Floor Stand, Motor Operator, Rising Stem	21' 3" Seating, 10' Unseating
	Slide Gate	Influent Screw Pump No. 2 Isolation	Non Self-Contained, CW	Up	42" x 42"	Floor Stand, Motor Operator, Rising Stem	21' 3" Seating, 10' Unseating
<u>Secondary Clarifier No 1 and 2 Distribution Box</u>							
	Weir Gate	Influent to SC No. 1	Wall Face Self-Contained	Down	72" x 48"	Floor Stand, Crank Operator, Rising Stem	4 ft Seating / Unseating
	Weir Gate	Influent to SC No. 2	Wall Face Self-Contained	Down	72" x 48"	Floor Stand, Crank Operator, Rising Stem	4 ft Seating / Unseating
<u>Secondary Clarifier No 3, 4 and 5 Distribution Box</u>							
	Weir Gate	Influent to SC No. 3	Open Frame Wall Face (Sealed on all 4 sides)	Down	72" x 24"	Floor Stand, Crank Operator, Rising Stem	4 ft Seating / Unseating
	Weir Gate	Influent to SC No. 4	Open Frame Wall Face (Sealed on all 4 sides)	Down	72" x 24"	Floor Stand, Crank Operator, Rising Stem	4 ft Seating / Unseating
	Weir Gate	Influent to SC No. 5	Open Frame Wall Face (Sealed on all 4 sides)	Down	72" x 24"	Floor Stand, Crank Operator, Rising Stem	4 ft Seating / Unseating

2.7 SPARE PARTS

- A. Provide one-year's supply of manufacturer recommended lubricants per the manufacturer's recommended lubrication schedule.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install equipment and accessories in accordance with manufacturer's instructions and recommendations and in conformance with the Contract Documents.
- B. Prepare concrete mounting surfaces for installation of gates.

3.2 PAINTING

- A. With the exception of those parts and components customarily furnished unpainted, all non-stainless steel metal surfaces shall be shop prepared and coated with rust inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified.
- B. Machined surfaces shall be protected against damage and corrosion by other means.
- C. Perform field painting in accordance with the Section entitled "Painting".

3.3 FIELD TESTING

- A. After installation, the Contractor shall operate all gates to show they operate without binding or strain.
- B. Any deficiencies shall be corrected at the Contractor's expense.
- C. Gates shall be tested under active operating conditions for a minimum of two (2) hours.
 - 1. Ensure leakage rate past seated gate does not exceed 0.10 gpm/ft of wetted perimeter.
 - 2. Verify proper operation of gate operators.
 - a. Unseat seated gate and run full-open.
 - b. Fully seat open gate.
 - c. Perform cycle a minimum of five (5) times.
 - 3. Verify the following for each gate:
 - a. Gate deflection is less than specified.
 - b. Stem deflection is less than specified.
 - c. Gate warpage/crowning is less than specified.
- D. Defective components shall be replaced or repaired and retested at no additional cost to the Owner.

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SECTION 35 20 16.2

ALUMINUM HYDRAULIC GATES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes aluminum gates, including sluice, slide and weir gates, complete with all appurtenances, as indicated in accordance with the Contract Documents.

1.3 RELATED SECTIONS

- A. Related Sections include the following:
 - a. Division 9
 - i. "Painting"
 - b. Division 40
 - i. "Electrically Operated Primary Control Valves"

1.4 QUALITY ASSURANCE

- A. Gates shall be the product of a single manufacturer.
- B. All materials furnished under this Section shall be furnished by manufacturers who have at least five years experience in the design, production, assembly, and field service of units of like type, size, and materials.
- C. References

Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

- 1. American National Standards Institute (ANSI)
 - 2. American Water Works Association (AWWA)
 - 3. American Welding Society (AWS)
 - 4. American Society for Testing and Materials (ASTM)
- D. Welding shall be performed in accordance with AWS standards or ASME Section IX.

- E. Gates and operators shall be furnished with all necessary parts and accessories; and shall be fabricated, assembled and placed in proper operating condition in accordance with installation instructions and recommendations of the equipment manufacturer.

1.5 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification are identified as provided below in Section 2.6 SCHEDULE.

1.6 SUBMITTALS

- A. Shop Drawings

1. In addition to those submittals identified elsewhere, the following items shall also be submitted in accordance with the General and Supplementary Conditions and Division 01:
 - a. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.
 - b. Shop drawings, including dimensions, material of construction, size and location of connections to other work, and weight of equipment.
 - c. Catalog information and cuts.
 - d. Complete manufacturer's specifications, including materials description and lubricant requirements.
 - e. Suggested spare parts list with current price information.
 - f. List of special tools required for checking, testing, parts replacement, and maintenance. Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.
 - g. List of special tools furnished with the equipment.
 - h. Special handling instructions.
 - i. Requirements for storage and protection prior to installation.
 - j. Manufacturer's installation recommendations.

- k. Requirements for routine maintenance required prior to startup.
- 1. Submit a coordination list that identifies each gate. The coordination list shall include project specific information such as tag numbers, gate type, size, and application.
- 2. Motor-Operated Gates
 - a. Submittals for motor-operated gates shall include electric actuator information as specified in the Submittals section of the specification entitled "Electrically-Operated Primary Control Valves". Submittal of the electric actuator shop drawings under a separate cover shall not be permitted.
 - b. The gate manufacturer shall submit written certification with the submittal of motor-operated gates that:
 - (1) The electric actuator supplied with the gate has been coordinated with the gate operating requirements.
 - (2) The gate manufacturer has reviewed the electric actuator shop drawings, and the shop drawings have been coordinated with the gates so as to provide a completely functional and operational system.
- B. Submit Operation and Maintenance Manuals for the gates in accordance the General and Supplementary Conditions and Division 01
- C. Submit Manufacturer's Certificate of proper installation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Materials and equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Such boxes, crates or protection shall be clearly labeled with manufacturer's name, brand or model designation, type or grade and color.
- B. Protect materials and equipment from exposure to the elements and keep dry at all times. Handle and store to prevent damage in accordance with manufacturer's recommendations.
- C. Material and equipment damaged by handling and storage shall be repaired or replaced by the Contractor as directed by the Engineer.

1.8 WARRANTY

- A. Gates and appurtenances shall be provided with manufacturer's warranty of not less than one (1) year from date of final acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers are as follows:

1. WACO Products Inc. (Series 5000)
2. Whipps, Inc (Series 800)
3. HydroGate
4. Or approved equal

2.2 GENERAL

- A. Furnish and install aluminum gates with frames and accessories suitable for high humidity and corrosive conditions.
- B. Aluminum gates shall be suitable for service in raw sewage.
- C. Gate assemblies shall be designed for mounting as indicated in the gate schedule.

2.3 PERFORMANCE REQUIREMENTS

- A. Gates shall be designed for the indicated seating and unseating heads.
- B. Gates shall conform to the requirements of AWWA C562, applicable to discs and frames with a safety factor of 5 with regard to tensile, compressive and shear strength.
- C. All gates shall meet the allowable leakage specified herein according to gate type.
- D. Materials of construction shall be suitable for the environment.
- E. Sluice Gates
 - 1. Gates shall be substantially watertight under the design head conditions. Under the design head, seating or unseating, as specified, the leakage shall not exceed 0.10 U.S. gallon per minute per foot (1.24 l/min per meter) of seating perimeter.
 - 2. The sluice gates shall be designed to withstand the design head shown in the schedule.
 - 3. The gate's sealing system should have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration
- F. Slide Gate
 - 1. Gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.10 U.S. gallon per minute per foot seal periphery under the design seating head and unseating head.

2. The slide gates shall be designed to withstand the maximum design head (maximum design head shall be taken as the height of the slide unless otherwise shown in the schedule).
3. The gate's sealing system should have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.

G. Weir Gates

1. Gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.10 U.S. gallon per minute per foot seal periphery under the design seating head and unseating head.
2. The weir gates shall be designed to withstand the maximum design head (maximum design head shall be taken as the height of the slide unless otherwise shown in the schedule).
3. The gate's sealing system should have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.

2.4 MATERIALS AND CONSTRUCTION

A. Frames

1. Guide frames shall be of extruded aluminum, Alloy 6061-T6. The vertical guides shall be designed for maximum rigidity. The vertical guides shall extend in one continuous piece from the gate invert to form posts for support of the operators, unless otherwise indicated. When guides extend above the operating floor, they shall be sufficiently strong so that no further reinforcements are required. Extruded aluminum guides shall weigh not less than four pounds per linear foot, and shall incorporate a replaceable extruded dense polyethylene bearing strip in an extruded retainer slot on both sides of the gate.
2. The frame invert shall be extruded aluminum, Alloy 6061-T6. The invert extrusion of aluminum gates shall weigh not less than two pounds per linear foot.
3. Vertical guide frames and inverts shall be joined with factory welded corners.
4. Guide slots shall be sized to provide a minimum disc engagement of one inch on each side.
5. Gates shall be either self-contained or non self-contained of the rising stem, non-rising or telescopic stem configuration as indicated on the gate schedule.

6. The frame shall be suitable for mounting on a concrete wall (CW) at the end of a channel, embedded inside a channel (FE) or mounted on the channel surface (EC). The guide slot shall be of UHMWPE (ultra high molecular weight polyethylene). The frame configuration shall be as indicated in the gate schedule.
7. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

B. Discs

1. The disc plate (sliding member) shall be one-piece aluminum plate, Alloy 6061-T6 cast iron ASTM A-126, Class B. The disc plate shall be reinforced such that the disc will not deflect more than 1/360 of the gate span, when the liquid depth on one side is the maximum seating/unseating head, and the liquid depth on the other side is less than 1/2 inch.
2. Aluminum gate discs shall be reinforced with one-piece aluminum angles or channel type extrusions welded to the disc plate. Bolted reinforcements will not be permitted.
3. Where "flush bottom" is indicated, provide a neoprene insert that shall function as a seating surface for the gate disc.

C. Operator Support Yoke

1. The yoke shall support the operator and shall be attached to the vertical extensions of the guide frames on self-contained gates.
2. The yoke assembly shall be constructed from at least two aluminum angles, or two other suitable extruded shapes, and shall be welded or bolted in-place to provide a rigid assembly.
3. Maximum deflection of the yoke assembly shall not exceed 1/4 inch under full operator applied loading.

D. Stems

1. Lifting stems shall be one-piece Type 304 stainless steel, with a minimum root diameter of one inch, and of ample cross-section to prevent distortion. Threaded portion of stem at operator end shall extend two inches above the operator when gate is in CLOSED position.
2. Stems shall be sized so that the ratio of the unsupported stem length (L) to the radius of gyration (r), both in inches, shall not exceed 200. Submit gate stem sizes for approval before manufacturing.
3. Stems shall be designed to withstand in compression, without damage, the thrust equal to at least 2-1/2 times the rated output of the hoisting

mechanism, with a 80-pound effort applied to the hand wheel and a 100 foot pound torque on a wrench nut.

4. Operating stems shall be equipped with cast iron, bushed stem guides, mounted on cast iron brackets. They shall be adjustable in two directions and shall be spaced so that the L/r ratio does not exceed 200. All stems shall be furnished with adjustable stop collar for the CLOSED position.
5. The stems shall be connected to the disc plate by means of an extruded or cast aluminum yoke, bolted to the stem and welded to the disc.
6. Slide gates having a width greater than twice the height shall have dual stems. For downward opening weir type gates, stems shall be located near outside edges of gate.
7. Gates and stems shall be threaded for opening in the direction scheduled below.
8. All stems to have clear acrylic covers.

E. Stem Covers

1. Rising stem extensions shall be provided with transparent plastic, vented pipe stem covers and caps. Provide stem covers with OPEN/CLOSED designators with one-inch graduations on clear Mylar, pressure sensitive, adhesive tape, suitable for outdoor application.

F. Sluice Gate Seals

1. Side and top seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate.
2. The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.

G. Slide Gate Seals

1. Side and top seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate.
2. Seals shall maintain the specified leakage rate in both seating and unseating conditions. The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.

H. Weir Gate Seals

1. The bottom and side seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open part of the gate.
2. Seals shall maintain the specified leakage rate in both seating and unseating conditions.

2.5 ACCESSORIES

A. Manual Gate Operators

1. Gates shall be provided with manual operators of the right-angle geared crank type with drill nut attachment. Operators shall be rising-stem with clear plastic cover with graduated gate position indicators.
2. Provide gearing as necessary to coordinate manual operator with space available at gate installation location.
3. Operators shall be sized to start the gate moving under maximum head pressure with a pull of not more than 40 pounds.
4. Provide indication of "OPEN" and arrow indicating direction of operator rotation to open gate.
5. The lifting mechanism shall be capable of withstanding, without damage, an effort of up to 200 pounds.
6. Provide manual operator with anti-friction brass or roller bearings.
7. Provide lubrication fittings for grease lubrication of bearings.
8. Provide floor stand for gate operators for open-frame gates.

B. Motor Operators

1. Motorized gate operators and positioners shall meet applicable requirements of the Section entitled "Electrically-Operated Primary Control Valves".

C. Anchor Bolts and Hardware

2. All necessary attaching bolts, anchor bolts, mounting and assembly hardware shall be of Type 316 stainless steel and shall be furnished by the gate manufacturer.

.2.6 SCHEDULE

- A. Provide aluminum gates as indicated in the Contract Documents and scheduled below. Operators are motor powered or manual handwheel as noted in the schedule.

<u>Tag No.</u>	<u>Style</u>	<u>Description</u>	<u>Gate Frame Mounting</u>	<u>Opening Direction</u>	<u>Dimensions W x H/Dia.</u>	<u>Operator Mounting</u>	<u>Head Conditions</u>
<u>Fine Screen Building</u>							
	Slide Gate	Fine Screen No. 1 Influent Isolation	Self-Contained, CW	Down	36" x 84"	Side Mount Chain Wheel Operator, Rising Stem	7' Seating/ Unseating
	Slide Gate	Fine Screen No. 2 Influent Isolation	Self-Contained, CW	Down	36" x 84"	Side Mount Chain Wheel Operator, Rising Stem	7' Seating/ Unseating
	Slide Gate	Fine Screen No. 1 Effluent Isolation	Self-Contained, FE	Up	36" x 84"	Side Mount Chain Wheel Operator, Rising Stem	7' Seating/ Unseating
	Slide Gate	Fine Screen No. 2 Effluent Isolation	Self-Contained, FE	Up	36" x 84"	Side Mount Chain Wheel Operator, Rising Stem	7' Seating/ Unseating
	Slide Gate	Fine Screen Bypass Channel Influent Isolation	Self-Contained, CW	Down	48" x 84"	Floor Stand, Motor Operator, Rising Stem	5.5' Seating/ Unseating
	Slide Gate	Fine Screen Bypass Channel Effluent Isolation	Self-Contained, FE	Up	48" x 84"	Floor Stand, Motor Operator, Rising Stem	5.5' Seating/ Unseating
<u>Primary Effluent Pump Station</u>							
	Slide Gate	Wet Well No. 1 Isolation	Non Self-Contained, CW	Up	36" x 36"	Floor Stand, Crank Operator, Rising Stem	15' Seating/ 18' Unseating
	Slide Gate	Wet Well No. 2 Isolation	Non Self-Contained, CW	Up	36" x 36"	Floor Stand, Crank Operator, Rising Stem	15' Seating/ 18' Unseating
<u>Anoxic Effluent Channel</u>							
	Slide Gate	Anoxic Effluent Channel No. 1 Isolation	Embedded bottom Self-Contained	Up	24" x 48"	Floor Stand, Crank Operator, Rising Stem	4.5 ft Seating / Unseating
	Slide Gate	Anoxic Effluent Channel No. 2 Isolation	Embedded bottom Self-Contained	Up	24" x 48"	Floor Stand, Crank Operator, Rising Stem	4.5 ft Seating / Unseating
	Sluice Gate	Anoxic Effluent Channel Transition Pipe No. 1	Wall Mounted Embedded bottom Self-Contained	Up	14" Diam	Floor Stand, Crank Operator, Rising Stem	4.5 ft Seating
	Sluice Gate	Anoxic Effluent Channel Transition Pipe	Wall Mounted Embedded	Up	14" Diam	Floor Stand, Crank Operator, Rising Stem	4.5 ft Seating

		No. 2	bottom Self- Contained				
	Sluice Gate	Anoxic Effluent Channel Transition Pipe No. 3	Wall Mounted Embedded bottom Self- Contained	Up	14" Diam	Floor Stand, Crank Operator, Rising Stem	4.5 ft Seating
	Sluice Gate	Anoxic Effluent Channel Transition Pipe No. 4	Wall Mounted Embedded bottom Self- Contained	Up	14" Diam	Floor Stand, Crank Operator, Rising Stem	4.5 ft Seating
	Sluice Gate	Anoxic Effluent Channel Transition Pipe No. 5	Wall Mounted Embedded bottom Self- Contained	Up	14" Diam	Floor Stand, Crank Operator, Rising Stem	4.5 ft Seating
	Sluice Gate	Anoxic Effluent Channel Transition Pipe No. 6	Wall Mounted Embedded bottom Self- Contained	Up	14" Diam	Floor Stand, Crank Operator, Rising Stem	4.5 ft Seating
<u>IR Well Isolation</u>							
	Weir Gate	IR Well No 4 Isolation	Wall Face Self- Contained	Down	60" x 42"	Floor Stand, Crank Operator, Rising Stem	4 ft Seating / Unseating
	Weir Gate	IR Well No 5 Isolation	Wall Face Self- Contained	Down	60 x 42"	Floor Stand Crank Operator, Rising Stem	4 ft Seating / Unseating
	Weir Gate	IR Well No 6 Isolation	Wall Face Self- Contained	Down	60" x 42"	Floor Stand, Crank Operator, Rising Stem	4 ft Seating / Unseating
<u>Tertiary Filters</u>							
	Slide Gate	Filter No. 1 Influent	Self- Contained CW	Up	36" x 36"	Crank Operator, Rising Stem	6 ft Seating / Unseating
	Slide Gate	Filter No. 2 Influent	Self- Contained CW	Up	36" x 36"	Crank Operator, Rising Stem	6 ft Seating / Unseating
	Slide Gate	Filter No. 3 Influent	Self- Contained CW	Up	36" x 36"	Crank Operator, Rising Stem	6 ft Seating / Unseating
	Slide Gate	Filter No. 4 Influent	Self- Contained CW	Up	36" x 36"	Crank Operator, Rising Stem	6 ft Seating / Unseating
	Slide Gate	Filter No. 1 Effluent	Self- Contained CW	Up	36" x 36"	Crank Operator, Rising Stem	10 ft Seating / Unseating
	Slide Gate	Filter No. 2 Effluent	Self- Contained CW	Up	36" x 36"	Crank Operator, Rising Stem	10 ft Seating / Unseating
	Slide Gate	Filter No. 3 Effluent	Self- Contained CW	Up	36" x 36"	Crank Operator, Rising Stem	10 ft Seating / Unseating

	Slide Gate	Filter No. 4 Effluent	Self-Contained CW	Up	36" x 36"	Crank Operator, Rising Stem	10 ft Seating / Unseating
	Slide Gate	Filter Bypass	Self-Contained EC	Up	48" x 48"	Crank Operator Rising Stem	10 ft Seating / Unseating

2.7 SPARE PARTS

- A. Provide one-year's supply of manufacturer recommended lubricants per the manufacturer's recommended lubrication schedule

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install equipment and accessories in accordance with manufacturer's instructions and recommendations and in conformance with the Contract Documents.
- B. Prepare concrete mounting surfaces for installation of gates.

3.2 PAINTING

- A. With the exception of those parts and components customarily furnished unpainted, all non-stainless steel metal surfaces shall be shop prepared and coated with rust inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified.
- B. Machined surfaces shall be protected against damage and corrosion by other means.
- C. Perform field painting in accordance with the Section entitled "Painting".

3.3 FIELD TESTING

- A. After installation, the Contractor shall operate all gates to show they operate without binding or strain.
- B. Any deficiencies shall be corrected at the Contractor's expense.
- C. Gates shall be tested under active operating conditions for a minimum of two (2) hours.
 - 1. Ensure leakage rate past seated gate does not exceed 0.10 gpm/ft of wetted perimeter.
 - 2. Verify proper operation of gate operators.
 - a. Unseat seated gate and run full-open.
 - b. Fully seat open gate.
 - c. Perform cycle a minimum of five (5) times.

3. Verify the following for each gate:
 - a. Gate deflection is less than specified.
 - b. Stem deflection is less than specified.
 - c. Gate warpage/crowning is less than specified.
- D. Defective components shall be replaced or repaired and retested at no additional cost to the Owner.

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SECTION 40 05 00

COMMON WORK RESULTS FOR PROCESS INTEGRATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for basic mechanical materials and methods for process mechanical systems. It applies to Divisions 40, 41, 43, and 46 and to other Sections that include process equipment requirements except when other requirements are specified. Process Mechanical systems shall be complete including all miscellaneous materials, and ready for operation as indicated in accordance with the Contract Documents.

1.3 QUALITY ASSURANCE

- A. Unless otherwise indicated, materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment shall be provided. The manufacturer's latest standard design that conforms to these Specifications shall be provided. When two or more units of the same class of equipment are required, these units shall be the products of the same manufacturer.
- B. Each major component of equipment shall have the manufacturer's name, address and model number on a nameplate attached to the item of equipment.
- C. Welding shall be performed by certified welders in accordance with the requirements of AWS D1.1 for the types of welding required on the Work.
- D. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. Structural members shall be designed for appropriate shock and vibratory loads.
- E. Materials and workmanship shall conform to the requirements of the latest editions of the following codes, regulations and specifications:

NFPA	AGA
UL	ARI
ASME	ANSI
AGMA	AWS
AMCA	AISC
AFBMA	

In addition, materials and workmanship shall conform to applicable local codes, regulations and ordinances. Adherence to the referenced codes and regulations shall constitute minimum requirements for the mechanical work. If a conflict arises between the codes and the Contract Documents, the more stringent requirements shall apply unless otherwise approved by the Engineer.

1.4 SUBMITTALS

- A. In addition to those submittals identified in the General and Supplementary Provisions, the following items shall also be submitted:
 - 1. Shop drawings for equipment and materials which shall include descriptive and published details concerning performance and capacity ratings for each piece of equipment. For electrical motor driven equipment, schematic drawings showing coordination with electrical system shall be included. Rated horsepower, rated current and electrical service requirements shall be provided.
 - 2. Catalog data for materials.
 - 3. Scaled mechanical layout working drawings showing dimensioned plan views and elevations of mechanical equipment; equipment mounting and foundations; and components including space conditions, coordination with building features and other work.
 - 4. Submit manufacturer's instructions and recommendations for installation, handling and storage, and cleaning and maintenance of equipment and materials prior to placing in service.
- B. Submit operation and maintenance manuals for each mechanical system and piece of equipment.
- C. Submit certificates of compliance for eight-inch and smaller diameter pipes, fittings and valves. See individual sections for submittal requirements for pipes, fittings and valves greater than eight-inch diameter.
- D. Submit manufacturer's certificates for material and equipment.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Contractor shall store and protect equipment specified herein in accordance with the requirements of Division 01.
- B. Materials and equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling and storage. Such boxes, crates or protection shall be clearly labeled with manufacturer's name, brand or model designation, type or grade and color.
- C. Materials and equipment shall be protected from exposure to the elements and shall be kept dry at all times. Items shall be handled and stored to prevent damage and in accordance with manufacturer's recommendation.

- D. Material and equipment damaged by handling and storage shall be repaired or replaced by the Contractor as directed by the Engineer, at no expense to the Owner.

1.6 JOB CONDITIONS

- A. The Contract Drawings indicate the extent and general arrangement of equipment, piping and ductwork. Equipment shall fit in the space allotted and allow adequate clearance for entry, installation, replacement, servicing and maintenance. Actual and final arrangement, location, grades and elevations of equipment, appurtenances, piping and ducts shall be verified by the Contractor before ordering material and equipment. If departures are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Engineer for approval as soon as practicable but not later than submittal of scaled mechanical shop drawings. No departure shall be made without the Engineer's written approval.
- B. The Work shall be coordinated so equipment may be moved in place without altering building components, other equipment or installations. Drops, rises or offsets not shown on the Contract Drawings but required for proper installation of the work shall be provided.

1.7 SAFETY REQUIREMENTS

- A. Belts, pulleys, chains, gears and other rotating parts shall be enclosed or properly guarded so personnel may safely be in close proximity thereto.
- B. Items such as catwalks, ladders and guardrails shall be provided where required for safe operation and maintenance of equipment.

1.8 SEQUENCING AND SCHEDULING

- A. Sequencing and scheduling of mechanical work shall be coordinated with the building construction and other related parts of the Work including verification that all structures, piping, wiring, conduits and equipment components are compatible.

1.9 MAINTENANCE MATERIALS

- A. Maintenance materials in the form of spare parts and extra material, if required, are specified in the specific Specification Section for equipment or materials.
- B. Spare parts listed to be furnished shall be packed in wooden boxes, labeled with the manufacturer's name, address and telephone number; local representative's name, address and telephone number; name of equipment the parts are for and list of parts contained therein.
- C. Extra material shall be packed in strong cartons, labeled with manufacturer's name, material name, type, color and location material was installed.
- D. Maintenance material shall be stored in a location directed by the Engineer.

1.10 MANUFACTURER'S SERVICES

- A. Manufacturers of furnished equipment shall provide qualified field representatives to provide manufacturer's services as required during installation, start-up, inspections/tests and to instruct the Owner's personnel on operation and maintenance of the equipment. Field representatives shall be available to observe, instruct, guide and direct the Contractor's handling, installation, start-up and adjustment procedures of the equipment. Manufacturer's services shall be provided as follows:
 - 1. Equipment shall be installed in accordance with the manufacturer's instructions but shall not be energized or operated until a field representative of the manufacturer has inspected the installation and is available on the site to supervise the equipment startup.
 - 2. Prior to and during the required inspections/tests, a field representative shall be available to operate and adjust the equipment to perform in accordance with the Contract Documents.
 - 3. When required in the specification Sections for the equipment, factory-trained service and operating personnel shall be provided to instruct the Owner's personnel in the operation and maintenance of the equipment. Instruction sessions shall be conducted at times and locations as approved by the Engineer.

PART 2 PRODUCTS

2.1 GENERAL

- A. In the design and supply of equipment, interchangeability of parts and items for equipment, piping, ductwork, motors and other appurtenances shall be provided.

2.2 EQUIPMENT BASES

- A. Equipment shall be provided with concrete bases a minimum of three and one-half to five and one-half inches high, unless otherwise indicated.
- B. Cast iron or welded steel baseplates shall be provided. Each unit and its drive assembly shall be supported on a single baseplate.

2.3 ANCHOR BOLTS

- A. Anchor bolts shall meet the requirements of the Section entitled "Metal Fabrications".
- B. Where cast-in-place anchor bolts are required, the Contractor shall provide anchor bolts together with template or setting drawing sufficiently in advance to permit anchor bolts to be set when structural concrete is being placed.

2.4 SUPPORTS AND BRACES

- A. Supports and braces fabricated shall be provided to meet requirements of the Section entitled "Metal Fabrications".

2.5 SAFETY GUARDS

- A. Belt and chain drives, fan blades, couplings and other moving and rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 or heavier gauge galvanized or aluminum-clad sheet steel or 1/2 inch mesh, galvanized expanded metal. Each guard shall be designed for easy installation and removal. Necessary supports and accessories, including bolts, shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized or stainless steel. Safety guards in outdoor locations shall be designed to prevent entrance of rain and dripping water.

2.6 LUBRICATION

- A. Equipment shall be lubricated by systems that require attention no more frequent than weekly during continuous operation. Lubrication facilities, oil drains and fill openings shall be accessible from normal operating area or platform. Drain ports shall allow for collection of waste oil in containers from operating area or platform without removing the unit from its installed position.

2.7 SHOP PAINTING

- A. Equipment, supports, piping, ductwork and appurtenances shall be surface prepared and shop coated as specified in the individual Sections including Section entitled "Painting" and as shown on the Contract Drawings except at connecting ends and where it hinders installation. These points shall be primed and field painted after installation. Shop primer shall be compatible with required field coat.

2.8 SPECIAL TOOLS AND ACCESSORIES

- A. Provide special tools, instruments and accessories when required to adjust, maintain or repair equipment. Equipment requiring special devices for lifting and handling shall be furnished complete with these devices.

PART 3 EXECUTION

3.1 PREPARATION

- A. Locations, areas and surfaces to receive mechanical equipment, piping, duct work and appurtenances shall be inspected to verify that areas are ready for installation. Before installation, defects and damaged areas shall be repaired, and surfaces and areas shall be adjusted by the contractor so they are ready for proper installation.
- B. Areas to be occupied by mechanical equipment and appurtenances shall be measured to verify that space is adequate and in accordance with approved Shop Drawings. If adjustment is required, approval from the Engineer shall be obtained to adjust any locations and equipment as approved.

3.2 INSTALLATION

- A. Equipment and appurtenances shall be installed in accordance with manufacturer's

instructions. The Contractor shall provide complete final connections to equipment, including pipe, duct, electric and controls.

- B. Whether shown or not, isolation valves and accessory fittings shall be provided on each side of equipment to allow the equipment to be removed and isolated for servicing. High points in piping shall be provided with manual vents and low points in fluid piping provided with drain valves fitted for hose adapters. Rises and drops as required by field conditions, whether shown or not, shall be provided. The above required items shall be provided by the Contractor at no additional cost to the Owner.
- C. Installation of mechanical systems, components and materials shall be coordinated with other portions of the work, including electrical wiring and conduit systems, structural supports and concrete work, and architectural work.

3.3 FOUNDATIONS, BASES AND SUPPORTS

- A. Equipment, ductwork, electrical conduits and piping shall be supported by providing compatible frames, braces, hangers and anchors.
- B. Unless otherwise shown on the Contract Drawings, floor mounted equipment shall be set on reinforced concrete pads a minimum of three and one-half to five and one-half inches high, doweled to the floor. Equipment pads and anchors shall be placed and set simultaneous with the floor. Baseplate, anchor bolts and vibratory absorption pad construction shall be provided as recommended by the equipment manufacturer. Baseplate shall be anchored to the concrete base with anchor bolts, leveled using shims or wedges, and the space beneath filled with quick setting non-shrink grout. After grout has hardened, anchor bolts shall be finally tightened and cut off not more than one inch nor less than 1/2 inch above top of nut. Leveling nuts under equipment bases shall not be used.
- C. Equipment suspended inside buildings shall be braced and supported to provide a rigid installation. Supports and hangers shall be attached to bearing walls, roof and floor supports, or framing members. Cross bracing shall be provided, as required, to develop a rigid installation.

3.4 ACCESS PANELS

- A. The Contractor shall provide access panels and openings where it will be necessary for maintenance and servicing of concealed equipment, piping and ductwork.

3.5 LUBRICATION

- A. Equipment shall be lubricated in accordance with manufacturer's instructions after installation and prior to initial operation. Following testing and prior to final acceptance, the Contractor shall lubricate the equipment again, if directed.

3.6 ADJUSTMENT AND INITIAL OPERATION OF EQUIPMENT

- A. Before systems and equipment are initially started, piping, ductwork and equipment shall be cleaned. Moving parts shall be checked for freedom of movement,

alignment and adjustment.

- B. The Contractor shall provide manufacturer's services as required herein before equipment is energized and operated. Adjustments shall be made as required and recommended by the manufacturer's representative.

3.7 SURFACE TOUCH-UP/FIELD PAINTING

- A. The Contractor shall touch-up surfaces where shop coats have been damaged using paint, coatings and film thickness identical to original shop coats.
- B. The Contractor shall clean field installed bolts, nuts, washers and support systems. Items shall be painted or coated identical to original shop coat and/or surrounding area.
- C. Field painting shall be performed as specified in the individual Sections including Section entitled "Painting" and as shown on Contract Drawings.

3.8 PROTECT AND CLEAN

- A. Equipment shall be protected during and after installation from construction dust and debris. Temporary protection shall be provided as required until equipment is in operation or receipt of Certificate of Substantial Completion.
- B. The Contractor shall clean equipment, surrounding area and ductwork inside and out.

3.9 FIELD QUALITY CONTROL

The Contractor shall demonstrate inspection and test the operation of the various systems and equipment in the presence of the Engineer as specified in the individual Sections for the equipment.

3.10 OPERATION INSTRUCTIONS

After the various systems have passed the field quality control requirements and prior to Certificate of Substantial completion, the Contractor shall provide manufacturer's services for operation and maintenance as specified in the individual Sections for the equipment.

* * * * *

SECTION 40 05 13

COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing process piping and accessories as indicated in accordance with the Contract Documents.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society of Mechanical Engineers (ASME)
 - 2. American Society for Testing and Materials (ASTM)
 - a. ASTM A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
 - b. ASTM A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
 - c. ASTM A194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
 - d. ASTM A216, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High- Temperature Service
 - e. ASTM A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
 - f. ASTM A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
 - g. ASTM A276, Standard Specification for Stainless Steel Bars and Shapes
 - h. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength
 - i. ASTM A312, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes
 - j. ASTM A536, Standard Specification for Ductile Iron Castings

- k. ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts
 - l. ASTM A774, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
 - m. ASTM A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products
 - n. ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings
 - o. ASTM B88, Standard Specification for Seamless Copper Water Tube
 - p. ASTM D1784, Specifications for Rigid Poly(vinyl chloride) (PVC) Compounds and Chlorinated Poly(vinyl chloride) (CPVC) Compounds
3. American National Standards Institute (ANSI) and American Water Works Association (AWWA)
- a. ANSI/AWWA C104/A21.4, Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
 - b. ANSI B16.1, Cast Iron Pipe Flanges And Flanged Fittings
 - c. ANSI B16.3, Malleable Iron Threaded Fittings
 - d. ANSI B16.5, Pipe Flanges and Flanged Fittings
 - e. AWWA C800, Underground Service Line Valves and Fittings (Also Included: Collected Standards for Service Line Materials)
4. American Welding Society (AWS)
- a. AWS A5.4, Stainless Steel Electrodes for Shielded Metal Arc Welding
 - b. AWS A5.9, Bare Stainless Steel Welding Electrodes and Rods
5. Manufacturer's Standardization Society of the Valve and Fitting Industry, Inc. (MSS)
- a. MSS SP-43, Wrought Stainless Steel Butt-Welding Fittings
6. National Sanitation Foundation (NSF)
7. Plastic Pipe Institute (PPI)
8. Steel Structures Painting Council (SSPC)
- a. SSPC-SP1, "Solvent Cleaning"
 - b. SSPC-SP3, "Power Tool Cleaning"

1.4 SUBMITTALS

A. Shop Drawings

1. Drawings showing the layout of pipes, fittings, drains, supports, anchoring, valves and equipment.
 2. Cross sections showing elevations of pipes, fittings, drains, supports, anchors, valves and equipment. Pipe size, type, materials and schedule.
 3. Detailed shop drawings of all supports, including support anchoring devices.
- B. Catalog data for pipe, fittings, drains, and cleanouts.
- C. Manufacturer's installation recommendations for trench floor drains.

PART 2 PRODUCTS

2.1 GENERAL

- A. Pipe of the same size and material shall be furnished by the same manufacturer. Each pipe length and fitting shall be clearly marked with the manufacturer's name or trademark.
- B. No change in material or joint selection will be permitted after submittal of shop drawings and their final review by the Engineer.
- C. Provide flexible couplings or expansion joints for piping and at connections to equipment in accordance with the Section entitled "Flexible Pipe Couplings".
- D. Provide piping support systems in accordance with the requirements of the Section entitled "Process Mechanical Hangers and Supports". No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any drawings shall not relieve the Contractor of the responsibility for providing them throughout the plant.
- E. Provide all piping penetrations of slabs, floors, walls, and roofs with wall pipes in accordance with the Section entitled "Wall Castings and Sleeves".
- F. Insulate piping in accordance with the requirements of the Section entitled "Process Mechanical Insulation".
- G. Tape Wrap
- Tape wrap shall be a minimum of 20 mils of butyl rubber or synthetic elastomeric adhesive and polyethylene-backed tape as manufactured by Polyken Division of the Kendell Company, Boston, MA; Royston Laboratories, Inc., Pittsburgh, PA; or approved equal.
- H. Heat Shrink Wrap
- Heat shrink wrap shall be a cross-linked polyolefin wrap or sleeve with a mastic sealant. Wrap or sleeves shall be Raychem WPC, TPS, flange seal, or approved

equal. Wrap type shall be as recommended by the manufacturer for the specific joint.

2.2 DUCTILE IRON PIPE SYSTEMS

- A. Ductile iron pipe systems shall meet the requirements of the Section entitled "Ductile Iron Piping and Fittings".

2.3 STAINLESS STEEL PIPE SYSTEMS

- A. Refer to Division 40 Section entitled "Stainless Steel Process Piping (Air, Low Pressure)" for ALP air piping requirements.
- B. Stainless steel pipe and fittings shall not have a lining and the outside shall not be painted.
- C. Pipe
 - 1. Stainless steel pipe shall be pickled and passivated, ASTM A778, type 304L, "as welded" grade, unless otherwise specified hereinafter.
 - 2. Pipes two-inch and smaller shall be ASTM A312, type 304, Schedule 40S, seamless.
 - 3. Pipes 2-1/2-inch and larger shall be Schedule 10S.
- D. Joints
 - 1. Joints two-inch and smaller shall be screwed.
 - 2. Joints 2-1/2-inch and larger shall be butt welded or flanged.
- E. Fittings
 - 1. Fittings two-inch and smaller shall be screwed, stainless steel, rated 1,000 pound CWP, forgings conforming to ASTM A182, Grade F304 or barstock to ASTM A276, Type 304, dimensions conforming to ANSI B16.3 for 150-pound SWP malleable iron screwed fittings.
 - 2. Fittings 2-1/2-inch and larger shall be butt welding type, stainless steel, pickled and passivated, schedule to match piping, ASTM A774, Type 304L, conforming to MSS SP-43; "as welded" grade; all elbows shall be long radius, unless otherwise designated.
- F. Branch Connections
 - 1. Branch connections two-inch and smaller shall be screwed tees as specified under "Fittings", or 3,000-pound WOG forged stainless steel, ASTM A182, Grade 304L commercial welding branch fittings with threaded outlet, as manufactured by Bonney Forge Division, Gulf and Western Industrial

Division, Allentown, PA; Allied Piping Products Co., Inc., Norristown, PA; or approved equal.

2. Branch connections 2-1/2-inch and larger shall be tees or reducing tees as specified under "Fittings" or fabricated from pipe.

G. Flanges

1. Flanges submerged below the overflow level of hydraulic structures shall be forged stainless steel, ASTM A182, Grade F316L, slip-on type, faced and drilled 150-pound, 1/16-inch raised face, ANSI B16.5 standard.
2. All other flanges shall be case steel backing flanges, ASTM A216, Grade WCA, Van Stone type, drilled 125-pound, ANSI B16.1 standard.

- H. Stub ends shall be stainless steel, ASTM A240, Type 304L, "as welded" grade, conforming to MSS SP-43, or flared nipples, schedule to match pipe.

I. Bolting

1. Type 316 stainless, ASTM A193, Grade B8M hex head bolts and ASTM A194, Grade 8M hex head nuts shall be provided for pipes and fittings submerged below the overflow level of hydraulic structures.
2. When the mating flange on valves or equipment is cast iron, use ASTM A307, Grade B, square head bolts and ASTM A563 Grade A heavy hex head nuts.

- J. Gaskets shall be 1/8-inch thick neoprene rubber, durometer hardness of No. 80, 1500 psi minimum tensile strength, 125 percent minimum elongation, flat ring type with RF flanges and full face type with FF flanges, Garlock Style 7797, or approved equal.

- K. Thread lubricant shall be Teflon tape.

- L. Covered welding electrodes for the shielded metal arc process for Type 304L pipe shall be AWS A5.4, E 308L.

- M. Welding rod and bare electrodes for the gas tungsten arc or gas metal arc processes for Type 304L pipe shall be AWS A5.9, ER 308L.

- N. Stainless steel pipe and fittings shall be as manufactured by:

1. Douglas Brothers Div., Robert Mitchell Co., Inc. Portland, ME
2. Tioga Pipe Supply Company, Inc., Philadelphia, PA
3. or approved equal

2.4 STAINLESS STEEL TUBING SYSTEMS

- A. Stainless steel tubing shall be of high quality, fully annealed Type 304 seamless meeting the requirements of ASTM A269.

- B. Fittings shall be stainless steel compression type.
- C. Stainless steel tubing and fittings shall be as manufactured by:
 - 1. Swagelock
 - 2. Parker CP1
 - 3. Or approved equal

2.5 POLYVINYL CHLORIDE (PVC) PIPE SYSTEMS

- A. PVC pressure pipe systems shall meet the requirements of the Section entitled "Polyvinyl Chloride (PVC) Pressure Pipe".
- B. PVC non-pressure pipe system shall meet the requirements of the Section entitled "Polyvinyl Chloride (PVC) Non-Pressure Pipe".
- C. See Double-Wall Secondary Containment Piping Systems below for PVC piping requiring secondary containment.

2.6 COPPER PIPE SYSTEMS

- A. Copper pipe shall be seamless, type K and meet requirements of ASTM B88. Copper piping shall be as manufactured by:
 - 1. Mueller Co.
 - 2. Halstead Industrial Products Group
 - 3. Howell Industries
 - 4. or approved equal
- B. Pipe joints for exposed copper piping shall be soldered. Pipe joints for buried copper piping shall be flared.
- C. Fittings shall be copper or brass meeting requirements of ASTM B62 and shall meet requirements of AWWA C800. Copper fittings shall be as manufactured by:
 - 1. The Ford Meter Box Company
 - 2. Hays, a Division of Romac Industries, Inc.
 - 3. James Jones Co.
 - 4. A.Y. McDonald Manufacturing Co.
 - 5. Mueller Co.
 - 6. Nibco
 - 7. or approved equal
- D. The iron pipe end of all copper-to-iron pipe fittings shall be threaded in accordance with American National Pipe Threads. Provide nylon dielectric bushings at copper pipe connections to ductile iron pipe.
- E. For copper couplings furnished by the Contractor, records of chemical analysis and tension results shall be systematically made and maintained by the manufacturer. Submit certified test reports in accordance with the General Provisions stating

conformance with the specifications and latest typical analysis and/or tension test results of current manufacture.

2.7 MISCELLANEOUS FITTINGS

A. Dielectric Unions and Insulating Couplings

1. Where connections between pipelines or equipment of corrosion causing dissimilar metals are required, the junction of the two dissimilar metals shall be made through a dielectric union, insulating coupling, or other approved dielectric insulating device.
2. Dielectric unions and bushings shall be as manufactured by:
 - a. Walter Vallett Company, Detroit, MI
 - b. EPCO, Inc., Cleveland, OH
 - c. Ford Meter Box Company
 - d. or approved equal
3. Insulating couplings shall be as manufactured by:
 - a. Dresser Industries, Style 39
 - b. Smith-Blair, Type 416 with Grade 60 gasket
 - c. or approved equal

B. Transition Couplings

1. Transition couplings shall be as manufactured by:
 - a. Dresser Industries, Style 162
 - b. Smith-Blair, Type 433 or 435
 - c. or approved equal

C. Clamp On Saddles

1. Clamp on saddle shall have cast body from ductile iron per ASTM A536. Saddle for connection of PVC piping to ductile iron piping shall be rated for 200 psi minimum. Gasket shall be nitrile butadiene rubber (NBR) gasket suitable for water and sewer service. Saddle shall have two 2-inch wide straps, of Type 304 heavy gauge stainless steel per ASTM A240, passivated for corrosion resistance. Saddle hardware shall be stainless steel.
2. Clamp on saddles shall be as manufactured by:
 - a. Romac Industries, Inc.
 - b. or approved equal

2.8 DOUBLE-WALL SECONDARY CONTAINMENT PIPING SYSTEMS

A. General

1. Yard piping used to convey chemical solutions as indicated in the Contract Documents shall be suitable for such purpose and shall be double wall containment piping.
2. Each contained piping system shall consist of a primary piping system supported with a secondary containment housing. Pipe Materials shall be Schedule 80 PVC or C-PVC as indicated on the Contract Drawings. Secondary piping material shall match that of the primary piping unless noted otherwise.
3. Interstitial supporting devices shall be provided within the secondary containment pipe and shall be designed to allow continuous drainage in the annular space to the drain points.
4. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment can be readily drained and manually checked for leaks.
5. Chemical piping diameters as shown on the Contract Drawings shall dictate the primary piping system's nominal diameter.

B. Materials

1. Carrier pipe and fittings shall be manufactured from schedule 80 PVC or CPVC materials as shown on the contract drawings and as listed by ASTM and ANSI.
2. Containment pipe and fittings shall be manufactured from schedule 80 PVC or CPVC materials as shown on the contract drawings and as listed by ASTM and ANSI.
3. Interstitial supporting devices used to center and support the primary piping within the secondary containment piping shall be manufactured from molded polypropylene Centra-Guide supports, or approved equal, per ASTM and ANSI qualifications.
4. All pre-fabricated pressure fittings or components shall be pretested by the manufacturer.
5. Double wall containment piping system materials shall be as manufactured by:
 - a. Guardian Systems as manufactured by IPEX
 - b. or approved equal
6. Terminate Secondary Containment piping at each end with termination fitting, Provide closure couplings as required to join piping.
7. Provide a minimum of one visual underground leak detection station (Guardian or approved equal) at the low point of each run of containment piping. Bring leak detection clean-out to grade. Provide a drain valve in the containment piping prior to a termination fitting to allow operators to depressurize piping system prior to leak inspection.

2.9 HDPE PIPING

A. HDPE pipe and fittings for gas service shall be as follows:

1. Pipe: ASTM D2513, 690 kPa (gage) 10 psig working pressure, Standard Dimension Ratio (SDR), the ratio of pipe diameter to wall thickness, 11.5 maximum.
2. Socket Fittings: ASTM D2683.
3. Butt-Fusion Fittings: ASTM D2513, molded.

A. Risers

1. Manufacturer's standard riser, transition from plastic to steel pipe with 0.18 to 0.30 mm 7 to 12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide wall-mounted riser supports.

B. Buried Utility Warning and Identification Tape

1. Provide detectable aluminum-foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 75 mm 3 inch minimum width, color-coded yellow for natural gas, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be "CAUTION BURIED GAS PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

PART 3 EXECUTION

3.1 GENERAL

A. Pipe Preparation and Handling

1. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed or the buried pipe or fitting is lowered into the trench. The interior and exterior protective coating shall be inspected, and all damaged areas patched in the field with material similar to the original, except damaged glass-lined pipe. Any damaged glass-lined pipe shall not be used and shall be promptly removed from the plant site. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.
2. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

B. Installation of Piping

1. Install piping in accordance with the requirements of the Section entitled "Pipeline Installation".
2. Piping shall be installed without springing or forcing the pipe in a manner that would set up stresses in the pipe, valves, or connected equipment.
3. Where valve operators are shown, valve orientation shall be as shown. Where valve operators are not shown, valves shall be oriented to permit easy access to the operators, and to avoid interferences.

C. Vents and Drains

Vent the high point and drain the low point of all pipelines, whether shown on the Drawings or not, with 3/4-inch ball valves on those pipelines 2-1/2-inch and larger and 1/2-inch ball valves on those pipelines two-inch and smaller.

D. Installation of Flexible Couplings, Flanged Coupling Adapters and Services Saddles

Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. If necessary, flexible couplings and flanged coupling adapter gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation of the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Workmen tightening bolts shall use torque-limiting wrenches.

E. Installation of Insulating Flanges, Couplings and Unions

Install insulating flanges, couplings, or unions wherever copper and ferrous metal piping are connected, wherever submerged metallic piping is connected to unsubmerged piping, and where shown on the Drawings. Insulated joints connecting submerged piping to exposed piping shall be installed above maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged metallic piping shall be isolated from the concrete reinforcement.

F. Insulation

Provide insulation for process mechanical piping in accordance with the Section entitled "Process Mechanical Insulation".

G. Interim Cleaning

Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, etc. within piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop cleaning may employ any conventional commercial

cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

H. Final Cleaning

1. Following assembly and testing and prior to final acceptance, all pipelines installed under this section, except plant process air lines and instrument air lines, shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 feet per second. Cone strainers shall be inserted in the connections to attached equipment and left here until cleaning has been accomplished to the satisfaction of the Engineer. Accumulated debris shall be removed through drains two-inch and larger or by dropping spools and valves.
2. Plant process air and instrument air piping shall be blown clean of loose debris with compressed air.

I. Corrosion Protection of Atmospheric Exposed Accessories

All atmospheric exposed surfaces of black and hot-dip galvanized steel, brass, copper and bronze piping components including, but not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves and fasteners shall be painted in accordance with the Section entitled "Painting".

J. Corrosion Protection for Copper Piping

1. For Atmospheric Exposed Copper Pipe

Copper piping shall be painted in accordance with the Section entitled "Painting" using System No. 6.

2. Exterior Coating for Buried Copper Pipe

Field coat buried copper pipe by hand with tape wrap. Solvent clean, SSPC-SP1, and wire brush, SSPC-SP3, pipe surfaces to remove all dirt, oxides, and foreign matter. Immediately prime with the tape manufacturer's recommended primer in accordance with the manufacturer's recommendations. The tape shall be spirally applied to the pipe with a 50 percent overlap minimum after the primer has thoroughly dried. Joints shall be tape wrapped or heat shrink wrapped above grade to permit joint wrapping without contamination.

3. Insulate all copper pipe from other piping systems with insulating couplings.

K. Corrosion Protection for Ductile Iron Pipe

Corrosion protection for ductile iron pipe and fittings shall be provided in accordance with the Sections entitled "Painting" and "Ductile Iron Pipe".

L. Pipe Painting and Color Coding

1. Painting and color coding of piping systems shall be as specified in the Section entitled "Painting".
2. Painting and color coding shall be applied to the exterior covering of insulated piping.
3. All bolts, nuts, couplings and the like shall be coated after the joint has been made. SS hardware shall not be painted.
4. There shall be no paint on bolts underground.
5. Where buried pipe connects to aboveground pipe, the coating and protection for the buried pipes shall extend six inches above finished grade.

3.2 FIELD QUALITY CONTROL

- A. Conduct pressure and leakage tests on all newly installed pipelines in accordance with the requirements of the Section entitled "Leakage Tests – Non-Structural".
- B. Prior to pressurizing or testing, solvent cement joints on PVC piping systems shall be allowed to cure a minimum of 24 hours or as approved by the Engineer.
- C. Test data shall be recorded for each piping system. These records shall include:
 1. Date of test.
 2. Description and identification of piping tested.
 3. Test fluid.
 4. Test pressure.
 5. Remarks, to include such items as:
 - a. Leaks (type, location).
 - b. Repairs made on leaks.
 6. Certification by Contractor and signed acknowledgement by Engineer.

3.3 BURIED PLASTIC LINES (GAS SERVICE)

- A. Provide totally HDPE piping. Prior to installation, obtain printed instructions and technical assistance in proper installation techniques from pipe manufacturer. (When joining new PE pipe to existing pipe line, ascertain what procedural changes in the fusion process is necessary to attain optimum bonding.)
- B. Prior to installation, Contractor shall have supervising and installing personnel, certified in accordance with paragraph entitled "Welder's Qualifications." Provide fusion-welded joints except where transitions have been specified. Use electrically heated tools, thermostatically controlled and equipped with temperature indication.

(Where connection must be made to existing plastic pipe, contractor shall be responsible for determination of compatibility of materials and procedural changes in fusion process necessary to attain maximum integrity of bond.)

- C. Laying HDPE Pipe: Bury pipe 600 mm 24 inches below finished grade (or deeper when indicated). Lay in accordance with manufacturer's printed instructions.
- D. Connections to existing Pipeline
 - 1. When making connections to live gas mains, use pressure tight installation equipment operated by workmen trained and experienced in making hot taps. For connections to existing underground pipeline or service branch, use transition fittings for dissimilar materials.
- E. Pressure Tests
 - 1. Use test pressure of $1 \frac{1}{2}$ times maximum working pressure, but in no case less than 350 kPa (gage) 50 psig. Do not test until every joint has set and cooled at least 8 hours at temperatures above 10 degrees C 50 degree F. Conduct testing before backfilling; however, place sufficient backfill material between fittings to hold pipe in place during tests. Test system gas tight in accordance with (NFPA 54) or (ASME B31.8). Use clean dry air or inert gas, such as nitrogen or carbon dioxide, for testing. Systems which may be contaminated by gas shall first be purged as specified. Make tests on entire system or on sections that can be isolated by valves.
 - 2. After pressurization, isolate entire piping system from sources of air during test period. Maintain test pressure for at least 8 hours between times of first and last reading of pressure and temperature. Take first reading at least one hour after test pressure has been applied. Do not take test readings during rapid weather changes. Provide temperature same as actual trench conditions. There shall be no reduction in the applied test pressure other than that due to a change in ambient temperature.
 - 3. Allow for ambient temperature change in accordance with the relationship $PF + 101.32 = (P1 + 101.32)(T2 + 273) / (T1 + 273)$ $PF + 14.7 = (P1 + 14.7)(T2 + 460) / T1 + 460$, in which "T" and "PF" represent Centigrade Fahrenheit temperature and gage pressure, "PF" is the calculated final pressure. If "PF" exceeds the measured final pressure (final gage reading) by $3 \frac{1}{2}$ kPa $\frac{1}{2}$ psi or more, isolate sections of the piping system, retest each section individually, and apply a solution of warm soapy water to joints of each section for which a reduction in pressure occurs after allowing for ambient temperature change.
 - 4. Repair leaking joints and repeat test until no reduction in pressure occurs. In performing tests, use a test gage calibrated in 7 kPa 1 psi increments and readable to $3 \frac{1}{2}$ kPa $\frac{1}{2}$ psi.
- F. System Purging
 - 1. After completing pressure tests, and before testing a gas contaminated line, purge line with nitrogen at junction with main line to remove all air and gas. Clear completed line by attaching a test pilot fixture at capped stub-in line at building location and let gas flow until test pilot ignites. Procedures shall conform to (NFPA 54) and (ASME B31.8).

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SECTION 40 05 13.19

STAINLESS-STEEL PROCESS PIPING (AIR, LOW PRESSURE)

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing stainless steel air main piping, complete with fittings and accessories, as indicated in accordance with the Contract Documents.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society of Mechanical Engineers (ASME)
 - 2. American Society for Testing and Materials (ASTM)
 - 3. American Welding Society (AWS)
 - 4. Manufacturer's Standardization Society of the Valve and Fitting Industry, Inc. (MSS)
 - 5. American National Standards Institute (ANSI)

1.4 SUBMITTALS

- A. Copies of affidavit from manufacturer that all materials furnished have been tested and comply with all applicable provisions of the Standards listed and this specification.
- B. Detail drawings of each size of pipe, fitting, and pipe support including joint type, diameters, pipe wall thicknesses, and dimensions.
- C. Layout drawings for pipe installation including location of joints, supports, anchors, and fittings.
- D. Copies of each of the following shop test results shall be submitted:
 - 1. Chemical and physical properties

2. Results of hydrostatic tests, including identification of each spool piece and component.
- E. Prior to the start of the work, Contractor shall submit a list of proposed welders and the type of welding for which each has been qualified.

PART 2 MATERIALS

2.1 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 1. Felker Brothers Corporation
 2. Scott Process Systems
 3. Or approved equal

2.2 STAINLESS STEEL PIPE AND FITTINGS

- A. Stainless steel pipe, pickled and passivated, shall be ASTM A778, type 304L, and shall be supplied with the following nominal wall thicknesses:

<u>Nominal Pipe Size</u>	<u>Wall Thickness</u>
2 - 8 inches	Schedule 5S
10 - 12 inches	12 Gauge
14 - 18 inches	11 Gauge
20 inches	10 Gauge
24 - 36 inches	3/16-inch
40– 48 inches	1/4-inch
54 – 60 inches	5/16-inch

- B. Joints for stainless steel pipe and fittings shall be provided as butt welded, coupled or flanged.
- C. Fittings shall conform to the following:
 1. Butt weld type, stainless steel, pickled and passivated, schedule to match piping, ASTM A774, Type 304L, conforming to MSS SP-43.
 2. All elbows shall be long radius, unless otherwise designated.
- D. Stub ends shall be stainless steel, ASTM A240, Type 304L, conforming to MSS-SP43, or flared nipples, schedule to match pipe.
- E. Flanged Joints
 1. Flanged pipe ends shall be made up of type 304L stainless steel slip-on type rolled angle face rings and primed ductile iron backup flanges drilled to ANSI 16.1 Class 125 standard or MSS SP44 or whatever may be required to match field connections, subject to approval by the engineer.

2. The angle face ring thickness shall be equal to or greater than the wall of the pipe or fitting to which it is welded and it shall be continuously welded on both sides to the pipe or fitting.
3. The angle leg shall not interfere with the flange bolt holes.
4. The back-up flanges shall be supplied with the following nominal thicknesses:

<u>Nominal Pipe Size</u>	<u>Flange Thickness</u>
less than 3-inches	1/2 inch
4 inches	9/16 inch
6 - 10 inches	5/8 inch
12 - 16 inches	3/4 inch
18-20 inches	7/8 inch
24-30 inches	1 inch
36 inches	1-1/8 inch
42 inches	1-1/4 inch
48 - 54 inches	1-3/8 inch
60 inches	1-1/2 inch

- E. Flanges shall be provided as a minimum at all flanged equipment items. Joints for shipping, handling, and installation shall be flanged or arched band couplings.
- F. Arched band type couplings shall be stainless steel of equal or superior alloy and wall thickness as the pipe and shall be Brico Depend-O-Lok type or approved equal. Couplings shall be Fixed - FxF. The pipe shall be plain end with external weld beads ground smooth with stainless steel restraining rings shop welded to the piping for fixed couplings.
- G. Bolts and Nuts
1. Unless otherwise specified, bolting shall be Type 316 stainless, ASTM A193, Grade B8M hex head bolts and ASTM A194, Grade 8M hex head nuts.
 2. When mating flange on valves or equipment is cast iron, use ASTM A307, Grade B, square head bolts and ASTM A563, Grade A heavy hex head nuts.
- H. Thread lubricant shall be Teflon tape.
- I. Covered welding electrodes for shielded metal arc process for Type 304L pipe shall be in accordance with AWS 5.4, E 308L.
- J. Welding rod and bare electrodes for gas tungsten arc or gas metal arc processes for Type 304 pipe and Type 304L pipe shall be in accordance with AWS 5.9, ER 308 and AWS5.9, ER 308L, respectively.

- K. Suitable dielectric insulation shall be provided to isolate dissimilar metals when applicable.
- L. Gaskets shall be 1/8-inch thick neoprene rubber, durometer hardness of No. 80, 1500 psi minimum tensile strength, 125 percent minimum elongation, flat ring type with RF flanges and full face type with FF flanges, Garlock Style 7797, or approved equal.
- M. Pipe anchors shall be placed where shown on the Drawings.

2.3 SOURCE QUALITY CONTROL

- A. Welding Procedure Qualification
 - 1. Furnish Engineer for prior review, procedure specifications and qualification records of welding procedures for all pipe welding to be performed under this Section, in accordance with AWS Standards.
- B. Shop Testing shall include the following:
 - 1. Chemical and physical properties.
 - 2. Hydrostatic test of all components, spool pieces, etc. to 12 psig.

PART 3 EXECUTION

3.1 FABRICATION AND INSTALLATION

- A. All fabrication and welding shall be performed in the shop by certified welders to ASME approved procedures and AWS Standards. Field welding shall not be permitted. All welding shall be by the shielded arc, inert gas, MIG or TIG method. Filler wire shall be added to all welds to provide a cross-section of weld metal equal to, or greater than, the parent metal. Inert gas shielding shall be provided to the interior and exterior of the joint. Interior weld beads shall be smooth, even, and not have an interior projection more than 1/16 inch beyond the I.D. of the pipe or fitting.
- B. Spools shall be fabricated to the "Pipe Fabrication Institute" fabricating tolerances ES-3 (1981).
- C. After manufacture, all pipe, fittings, supports, specials, etc. shall be preferably passivated by immersion in an air agitated pickling tank containing a 25% solution of nitric and hydrofluoric acids for 40 to 50 minutes. The acid shall be neutralized by immersion in a rinse tank containing clean water and tri-sodium phosphate.
- D. After welding, all welded joints shall be cleaned with an industry standard cleaning solution, brushed with stainless wire brushes, and rinsed clean.
- E. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece marked with identifying numbers or codes which correspond to the contractor's layout and

installation drawings. The marks shall be located on the spools at opposite ends and 180 degrees apart.

- F. The piping supplier during manufacturing, fabrication, and handling stages, and the contractor during handling and installation stages, shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc., shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be non-ferrous or stainless steel or rubber lined. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the contractor shall wash and rinse all foreign matter from the piping surface. If rusting of embedded iron occurs, the contractor shall pickle the affected surface with Oakite Deoxidizer SS or approved equal, scrub with stainless steel brushes, and rinse clean.
- G. Provide flexible couplings or expansion joints for piping and at connections to equipment where shown on the Drawings, in accordance with the Section entitled "Flexible Pipe Couplings". The Contractor may install additional pipe anchors and flexible couplings to facilitate piping installation, provided that he submits complete details describing location, pipe supports, and thrust protection.
- H. Expansion couplings for air piping may also be Victaulic Depend-O-Lok FxE couplings. Depend-O-Lok couplings shall be Type 316L stainless steel arched band type couplings, with maximum allowable expansion / contraction of 4 inches. Coupling sealing plates, bolts, nuts, washers, and retaining ring shall be Type 316L stainless steel. Coupling O-rings shall be of a grade suitable for 300 deg F air service. Coupling shall be secured to one pipe end with stainless steel retaining rings shop welded by the pipe fabricator to the pipe end for the fixed side of the coupling.

3.2 SUPPORTS

- A. Two support types shall be used as indicated on the Contract Drawings: fixed support and sliding support.
 - 1. The fixed piping support shall prevent the pipe from movement in any plane (bolted to pipe support).
 - 2. The sliding support shall allow the pipe to expand or contract a maximum movement of 3 inches in the pipe's longitudinal direction and a maximum movement of 1.5 inches in lateral direction (sideways). The pipe shall be prevented from any upward movement by the use of guides or slots. The pipe saddle shall slide on a Teflon plate or similar material intended for this use.
- B. Pipe saddles for support of stainless steel air mains shall be manufactured from 1/4" Type 304 stainless steel plate, with a minimum polar straddle of 120 degrees.

3.3 FIELD TESTING

- A. All sections of pipelines shall be cleaned and flushed prior to testing.
- B. All pipelines shall be tested with air at 15 psi test pressure. Test pressure shall be held on the piping for a period of at least 2 hours, unless a longer period is requested by the Engineer.
- C. No leakage will be allowed during the test.
- D. The equipment required for air testing shall be furnished by the Contractor and shall include the necessary compressor, valves and gauges to allow for the monitoring of the pressure, release of pressure and a separable test gauge.
- E. The test gauge shall be have a maximum range of 0 to 50 psig and shall be graduated in one-tenth psig increments and shall be on a separate line to the test section.

3.4 PAINTING

- A. After installation, paint all steel or iron flanges, couplings, and appurtenances per requirements of the Section entitled "Painting". SS hardware shall not be painted.
- B. Painting of stainless steel pipe is not required. However, stainless steel piping shall be supplied and installed with a consistently clean surface. Identifying spool piece marks shall be removed with paint thinner or solvents.

* * * * *

SECTION 40 05 13.20

POLYVINYL CHLORIDE (PVC) NON-PRESSURE PIPE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes polyvinyl chloride non-pressure pipe as shown on the Contract Drawings, complete with accessories.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society for Testing and Materials (ASTM)

1.4 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions and Division 01, the following items shall be submitted:
 - 1. Drawings and manufacturer's data of the pipe, joints and fittings showing compliance with this specification.
 - 2. Manufacturer's certification that all materials are in compliance with the applicable requirements of the referenced standards and this specification.

PART 2 PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

- A. Polyvinyl chloride pipe shall be made from Class 12454-B materials or better in accordance with ANSI/ASTM D 1784.
- B. Polyvinyl chloride pipe and accessories shall conform to the requirements of the following with a minimum pipe stiffness of 46 psi at a maximum deflection of 5%:

ANSI/ASTM	D3034 (4"-15")
ASTM	F679 (18"-27")

2.2 ACCESSORIES

A. Fittings and Couplings

1. Polyvinyl chloride fittings and couplings shall conform to the requirements of the PVC pipe for classification and size.

B. Joints

1. Joints shall be as shown in the Contract Drawings.
2. Rubber gaskets for elastomeric joints shall conform to ANSI/ASTM F477.
 - a. Lubricant for the joints shall be furnished by the pipe manufacturer.
 - b. The rubber gaskets shall be factory installed in the bell of the pipe, fittings and couplings.
3. The plain end of the pipe shall be marked by the manufacturer to show the depth of penetration into the bell or coupling.
4. The solvent for solvent welded joints shall be furnished by the pipe manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install polyvinyl chloride pipe, fittings, specials, and accessories in accordance with the configuration shown on the Contract Drawings and the applicable provisions of the Sections entitled "Trenching, Backfilling and Compacting" and "Pipeline Installation".
- B. Polyvinyl chloride pipe shall be handled and stored in accordance with the manufacturer's recommendations.
- C. The Contractor shall TV all non-pressure PVC pipe drain lines.

3.2 FIELD TESTING

- A. Pipe deflection shall be checked by passing a deflection gauge through all completed pipelines.
 1. Maximum deflection allowed 5%.
 2. The test for deflection shall be made not less than 30 days after the completion of the installation.
 3. Deflection gauge shall be pulled through the pipe by hand.
 4. Any section of pipe found to have a deflection in excess of 5% shall be corrected by the Contractor.

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SECTION 40 05 13.21

DUCTILE IRON PIPING AND FITTINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for centrifugally cast ductile iron pipe and fittings as indicated in accordance with the Contract Documents.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - 2. American Water Works Association (AWWA)
 - 3. American Society for Testing and Materials (ASTM)

1.4 SUBMITTALS

- A. In addition to those submittals identified in the General Provisions, the following items shall be submitted:
 - 1. The manufacturer shall furnish statements that all of the specified tests have been made and the results thereof comply with the requirements of the specified standards.
 - 2. Pipe and joint details.
 - 3. Layout drawings for ductile iron pipe to be installed within structures showing the location including details of the support system, joint restraints, sleeves and appurtenances.
 - 4. Layout drawings are required for all yardpiping showing the location including fittings and joint restraint systems.

PART 2 PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

- A. Ductile Iron Pipe

1. Ductile iron pipe and ductile iron fittings shall comply with the following standards:

ANSI/AWWA

Ductile Iron Pipe	C151
Fittings	C153
Joints-Mechanical and Push-On	C111
Joints-Flanged	C115
Cement Lining	C104

- B. All shipments of material shall be tested in accordance with the provisions for testing in the applicable standards.

2.2 ACCESSORIES

A. Joints

1. The type of joints for ductile iron pipe and fittings shall be as shown on the Contract Drawings.
2. Flanged joints shall be assembled with through bolts of the size required for the pipe being installed. Stud bolts shall be used only where shown or required. Connecting flanges shall be in proper alignment and no external force shall be required or used to bring them together. Ductile iron pipe to be used with flanged joints shall be AWWA Thickness Class 53.
 - a. Flanges for flanged joints shall be drilled for 125 psi pressure unless otherwise specified.
 - 1) Flange bolts and nuts shall be steel, ASTM A307, Grade B, and shall be zinc or hot dipped galvanized unless otherwise indicated in the Contract Documents.
 - 2) Flange bolts and nuts shall be stainless steel for buried or submerged locations.
 - 3) Gaskets for flanged joint piping shall be full-faced, 1/8 inch thick rubber gaskets meeting requirements of AWWA C111 for water and sewage application.
 - 4) Gaskets for other service shall be as specified.
3. Grooved and shoulder type joints of the rigid design will not be allowed in lieu of flanged joints without the prior acceptance of the Engineer, except where specifically called for in the Contract Documents. Grooved and shoulder type joints of the rigid design shall be in accordance with AWWA C606 and Table 5 for iron pipe.
 - a. Bolts and nuts shall be stainless steel.

- b. Details of supports, anchors and couplings shall be submitted for review.
- 4. Force main pressure pipes shall have all joints, fittings and valves restrained against thrust using restrained joints. Low pressure full flowing gravity piping shall have restrained joints where indicated on the drawings. For each system, the number of joints to be restrained up and downstream of a change in direction shall be determined by the restraint manufacturer and submitted with the shop drawings for review. Thrust blocks will be not be allowed, unless approved by the Engineer. Restrained joints shall be manufactured by one of the following:
 - a. TR Flex by U.S. Pipe
 - b. Flex-Ring or MJ Coupled Joint by American Ductile Iron Pipe Company
 - c. Megalug by EBAA Iron, Inc.
 - d. Approved Equal.
- 5. Rubber gaskets with metal inserts which hold by wedging into the spigot end of the pipe shall not be used as a restrained joint.
- 6. Mechanical joints shall be assembled in accordance with the Notes on Method of Installation, AWWA C111, Appendix A. All bolts shall be high strength, stainless steel and shall be tightened by means of torque wrenches such that the follower shall be brought up evenly. If effective sealing is not obtained at the specified torques, the joint shall be disassembled, cleaned and reassembled.
- 7. Push-on joints shall be assembled using lubricant furnished by the manufacturer. The joint shall be made by guiding the plain end into the bell until contact is made with the gasket and exerting sufficient force to drive the pipe home until penetration is made to the depth recommended by the manufacturer.
- 8. All buried ductile iron pipe shall be minimum thickness class 52.

2.3 COATING, PAINTING AND LINING

- A. Coating, painting and lining shall be as follows unless otherwise indicated in the Contract Document:
 - 1. Pipe installed in the ground, in exposed exterior locations, in contact with water or inside structures but not specified for painting:
 - Interior: Standard thickness cement lining with sealcoat unless otherwise specified.
 - Exterior: Bituminous coating.

2. Pipe installed inside structures or specified for painting:
 - Interior: Standard thickness cement lining with sealcoat unless otherwise specified.
 - Exterior: Pipes with bituminous coatings shall be coated with Inertol "Tar Stop", or Mobil Anti-Bleeding Sealer Aluminum 13-A-1 or approved equal, or sandblasted as specified, before additional coats are applied.
3. Pipe used for plant utility water as shown on the Contract Drawings:
 - Interior: Double thickness cement lining as defined per AWWA C104, with sealcoat unless otherwise specified.
 - Exterior: As specified above.
4. Glass-lined pipe where indicated in the Contract Documents:
 - Interior: Standard thickness (6-10 mils nominal) glass lining as manufactured by Water Works Supply Co. (Ferrock MEH-32), Ervite Corporation (Ervite SG-14), or Approved Equal.
 - Exterior: As specified above.
5. Bituminous coatings shall be coal tar epoxy, Koppers Bitumastic No. 300M, Tnemec No. 413 Tneme-Tar, or approved equal, applied to a minimum thickness 1 mil. Coatings in contact with potable water shall meet requirements of AWWA C203 and jurisdictional Health Department requirements.

PART 3 EXECUTION

3.1 INSTALLATION AND HANDLING

- A. Ductile iron pipe shall be installed in accordance with the applicable provisions of the Sections entitled "Trenching, Backfilling and Compacting" and "Pipeline Installation".
- B. All ductile iron pipe and fittings shall be handled with padded slings or other appropriate equipment. The use of cables, hooks or chains will not be permitted.
- C. Where restrained joints are used, joints shall be assembled in accordance with the manufacturer's instructions. Pipe sockets should be fully extended after the locking segments are installed to ensure that the locking segments are seated.

3.2 FIELD TESTING AND CHLORINATION

- A. Perform hydrostatic and leakage tests in accordance with the applicable provisions of the Section entitled "Leakage Tests – Non-Structural", at the test pressure specified or scheduled.

- B. Disinfect piping and appurtenances in accordance with the Section entitled "Chlorination", as specified.

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SECTION 40 05 13.22

POLYVINYL CHLORIDE (PVC) PRESSURE PIPING AND FITTINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes polyvinyl chloride (PVC) pressure pipe as shown on the Contract Drawings, complete with accessories.

1.3 QUALITY ASSURANCE

- A. Inspect pipe upon delivery, remove rejected pipe immediately.
- B. Reject pipe of any manufacturer if more than five unsatisfactory joint assembly operations or “bell breaks” occur in 100 consecutive joints, even if the pipe conforms to ASTM Specifications. Remove unsatisfactory pipe of that manufacturer of same shipment from work site. Furnish pipe of another manufacturer conforming to these specifications.
- C. Perform tests in accordance with methods prescribed by ASTM and AWWA specifications. Accept or reject based on the test results.

1.4 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society for Testing and Materials (ASTM)
 - a. D-1784 – Specifications for Rigid Poly(vinyl chloride) (PVC) Compounds and Chlorinated Poly(vinyl chloride) (CPVC) Compounds
 - b. D-1785 – Specifications for Poly(vinyl chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
 - c. D-2672 – Specifications for Joints for IPS PVC Pipe Using Solvent Cement

- d. D-2855 – Practice for Making Solvent-Cemented Joints with Poly(vinyl chloride) (PVC) Pipe and Fittings
- e. D-3139 – Specifications for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
- f. F-402 – Standard Practice for Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
- 3. American Water Works Association (AWWA)
 - a. C900 – Polyvinyl chloride (PVC) Pressure Pipe
- 4. National Sanitation Foundation (NSF)

1.5 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions and Division 01, the following items shall be submitted:
 - 1. Manufacturer's certification that all materials furnished are in compliance with the applicable requirements of the referenced standards and this specification.
 - 2. The manufacturer shall furnish statements that all of the specified tests have been made and the results thereof comply with the requirements of the specified standards.
 - 3. Drawings and manufacturers data of the pipe, joints and fittings showing compliance with this specification.
 - 4. Layout drawings for polyvinyl chloride pressure pipe to be installed within structures showing the location including details of the support system, joint restraints, sleeves and appurtenances.
 - 5. Layout drawings are required for all yardpiping showing the location including fittings and joint restraint systems.

PART 2 PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

- A. Pipe, Fittings, and Specials
 - 1. All pipe, fittings and specials shall conform to ASTM D-1785 or AWWA C900.
 - 2. All material shall be PVC Class 12454-B, virgin compound, per ASTM D1784 with an established hydrostatic design basis (HDB) rating of 4000 psi for water at 73.4 deg. F (23 deg C) designated PVC 1120.

3. Pipe 3-1/2" and smaller shall either be Schedule 40 or Schedule 80 as indicated on the Contract Drawings or specified. Piping shall conform to ASTM D1784 and ASTM D1785.
4. Pipe 4" and larger shall be DR-18 and conform to AWWA C900, cast iron (CI) OD.
5. All fittings shall be of same material and classification as pipe. All flanged fittings shall be compatible with the material being transported within the pipe or any materials that may come in contact to the pipe during normal operation.
6. All gaskets shall be compatible with the material being transported within the polyvinyl chloride pipe. EPDM gaskets are unacceptable with the use of sodium hypochlorite.
7. Polyvinyl chloride pipe and accessories to be used for potable-water shall be certified as suitable by the NSF or other approved testing agency and shall be marked with the seal of the agency.

B. Joints

1. Joints 3-in. and larger:
 - a. Joints shall either be elastomeric gasket joints or solvent-cement joints as indicated on the Contract Drawings or otherwise specified.
 - b. If elastomeric gaskets are to be used, gasket shall be of synthetic rubber; resistant to common ingredients of sewage and industrial wastes, including oils and groundwater, capable of enduring permanently under conditions of proposed use.
2. Joints 2-in and smaller:
 - a. Joints shall be solvent-cement, with sockets (bells) per ASTM D2672, or push-on type per ASTM D3139. Do not use threaded joints, unless specifically called in the Contract Documents.

C. Flexible PVC Tubing

1. Where indicated in the Contract Documents, carrier piping for chemical feed systems shall be flexible reinforced clear PVC tubing with minimum pressure rating of 150 psi, as manufactured by IPT Harrington (Nalgene, Series 980); Cole-Palmer Instrument Company; or Approved Equal.
2. All fittings shall be pressure rated at 100 psi minimum and shall be as manufactured by IPT Harrington (Nalgene "Softube" Fittings).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install polyvinyl chloride pressure pipe, fittings, specials, and accessories in accordance with applicable Sub-Sections of the Sections entitled "Trenching, Backfilling, and Compacting", "Pipeline Installation" and "Pipe Hangers and Supports".
- B. Clear pipe units of debris and dirt before installation and keep clean until acceptance.
- C. Make solvent-cement joints in accordance with ASTM D2855. Observe precautions per ASTM F402. The splitting and rewelding of fittings shall not be permitted. The solvent being used for the bonding of the polyvinyl chloride pipe sections shall be compatible with the material being transported within the pipe. The contractor shall supply documentation of chemical compatibility of the solvent and the material to be transported.
- D. Make open ends of pipe and branches watertight with temporary plugs when pipe installation not in progress.
- E. Make Provisions to prevent water, earth, or other substances from entering pipeline.
- F. All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualification procedures described in ASME B 31.3 chapter VII for bonding of plastic piping. The bonding qualification procedure shall be that as written and provided by the manufacturer.
- G. Pipes running through, directly over, or in front of electrical switchboards, power panels etc are not acceptable.
- H. Install all piping in such a manner as to allow freedom to expand and contract at least 3/4 in. per 100 ft.
- I. Install piping to provide not less than 3-in. clearance from walls, ceilings, floors, and other piping systems or electrical conduits, etc. measure clearance from outside surface of pipe or flange, whichever is greater.
- J. Provide pipe supports complete with all accessories such as clamps, bolts, nuts, washers, rods, intermediate structural steel members when necessary, etc.
- K. Drawings do not generally indicate locations or types of hanger; however, provide complete support systems as necessary to allow satisfactory operation of each system. Where piping supports or accessories are indicated, information is supplied to indicate typical Provisions for involving more critical consideration due to expansion, thrust or other conditions. Adapt the indicated typical conditions as necessary to suit actual system requirements.
- L. Locate hangers on all systems so as to provide at least one hanger immediately adjacent to each change of direction, offset, and provide additional hangers wherever concentrated loads occur in piping system from installation of in-line equipment.

3.2 INSPECTION

- A. Inspect each pipe length and each fitting before installation. Remove defective pipe and fittings. Replace with sound pipe and fittings.

3.3 HANDLING

- A. Polyvinyl chloride pressure pipe shall be handled and stored in accordance with the manufacturer's recommendations.
 - 1. Store until installation in a place acceptable to Engineer; keep place at ambient outdoor temperature.
 - a. Provide temporary shading.
 - b. Do not use covering causing temperature build-up.
- B. Handle into position to avoid damage in a manner acceptable to Engineer.

3.4 FIELD TESTING

- A. Perform hydrostatic and leakage tests in accordance with the applicable Provisions of the Section entitled "Leakage Tests – Non-Structural", at the test pressure specified.
 - 1. Clean pipe of dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.

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SECTION 40 05 13.24

CHLORINATED POLYVINYL CHLORIDE (CPVC) PRESSURE PIPE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes chlorinated polyvinyl chloride (CPVC) pressure pipe as shown on the Contract Drawings, complete with accessories.

1.3 QUALITY ASSURANCE

- A. Inspect pipe upon delivery, remove rejected pipe immediately.
- B. Reject pipe of any manufacturer if more than five unsatisfactory joint assembly operations or “bell breaks” occur in 100 consecutive joints, even if the pipe conforms to ASTM Specifications. Remove unsatisfactory pipe of that manufacturer of same shipment from work site. Furnish pipe of another manufacturer conforming to these specifications.
- C. Perform tests in accordance with methods prescribed by ASTM and AWWA specifications. Accept or reject based on the test results.

1.4 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society for Testing and Materials (ASTM)
 - a. F1970-05 – Standard Specification for Special Engineered Fittings, Appurtenances and Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems
 - b. F493-04 – Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
 - c. F441/F441M-02 – Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

- d. D1784-06a – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
 - e. F442/F442M-99(2005) – Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
 - f. D3139 – Specifications for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
 - g. F402 – Standard Practice for Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
- 3. American Water Works Association (AWWA)
 - 4. National Sanitation Foundation (NSF)

1.5 SUBMITTALS

- A. In addition to those submittals identified in the General Provisions, the following items shall be submitted:
 - 1. Manufacturer's certification that all materials furnished are in compliance with the applicable requirements of the referenced standards and this specification.
 - 2. The manufacturer shall furnish statements that all of the specified tests have been made and the results thereof comply with the requirements of the specified standards.
 - 3. Drawings and manufacturers data of the pipe, joints and fittings showing compliance with this specification.
 - 4. Layout drawings for chlorinated polyvinyl chloride pressure pipe to be installed within structures showing the location including details of the support system, joint restraints, sleeves and appurtenances.
 - 5. Layout drawings are required for all yardpiping showing the location including fittings and joint restraint systems.

PART 2 PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

- A. Pipe, Fittings, and Specials
 - 1. All pipe, fittings and specials shall conform to ASTM F1970-05.
 - 2. All material shall be CPVC Class 23447-B, virgin compound, per ASTM D1784 with an established hydrostatic design basis (HDB) rating of 2000 psi for water at 73.4 deg. F (23 deg C).

3. Pipe shall either be Schedule 80 as indicated on the Contract Drawings or specified.
 4. All fittings shall be of same material and classification as pipe. All flanged fittings shall be compatible with the material being transported within the pipe or any materials that may come in contact to the pipe during normal operation.
 5. All gaskets shall be compatible with the material being transported within the chlorinated polyvinyl chloride pipe.
- B. Joints
1. Joints 3-in. and larger:
 - a. Joints shall either be elastomeric gasket joints or solvent-cement joints as indicated on the Contract Drawings or otherwise specified.
 - b. If elastomeric gaskets are to be used, gasket shall be of synthetic material resistant to the chemical service indicated, capable of enduring permanently under conditions of proposed use.
 2. Joints 2-in and smaller:
 - a. Joints shall be solvent-cemented. Do not use threaded joints, unless specifically called in the Contract Documents.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install chlorinated polyvinyl chloride pressure pipe, fittings, specials, and accessories in accordance with applicable Sub-Sections of the Sections entitled "Trenching, Backfilling, and Compacting", "Pipeline Installation" and "Pipe Hangers and Supports".
- B. Clear pipe units of debris and dirt before installation and keep clean until acceptance.
- C. Make solvent-cement joints in accordance with ASTM F493. Observe precautions per ASTM F402. The splitting and rewelding of fittings shall not be permitted. The solvent being used for the bonding of the polyvinyl chloride pipe sections shall be compatible with the material being transported within the pipe. The contractor shall supply documentation of chemical compatibility of the solvent and the material to be transported.
- D. Make open ends of pipe and branches watertight with temporary plugs when pipe installation not in progress.
- E. Make provisions to prevent water, earth, or other substances from entering pipeline.
- F. All contractor personnel that will prepare solvent cemented joints shall be qualified for such bonding practices according to the bonding qualification procedures described in

ASME B 31.3 chapter VII for bonding of plastic piping. The bonding qualification procedure shall be that as written and provided by the manufacturer.

- G. Pipes running through, directly over, or in front of electrical switchboards, power panels etc., are not acceptable.
- H. Install all piping in such a manner as to allow freedom to expand and contract at least 3/4 in. per 100 ft.
- I. Install piping to provide not less than 3-in. clearance from walls, ceilings, floors, and other piping systems or electrical conduits, etc. measure clearance from outside surface of pipe or flange, whichever is greater.
- J. Provide pipe supports complete with all accessories such as clamps, bolts, nuts, washers, rods, intermediate structural steel members when necessary, etc.
- K. Drawings do not generally indicate locations or types of hanger; however, provide complete support systems as necessary to allow satisfactory operation of each system. Where piping supports or accessories are indicated, information is supplied to indicate typical provisions for involving more critical consideration due to expansion, thrust or other conditions. Adapt the indicated typical conditions as necessary to suit actual system requirements.
- L. Locate hangers on all systems so as to provide at least one hanger immediately adjacent to each change of direction, offset, and provide additional hangers wherever concentrated loads occur in piping system from installation of in-line equipment.

3.2 INSPECTION

- A. Inspect each pipe length and each fitting before installation. Remove defective pipe and fittings. Replace with sound pipe and fittings.

3.3 HANDLING

- A. Chlorinated polyvinyl chloride pressure pipe shall be handled and stored in accordance with the manufacturer's recommendations.
 - 1. Store until installation in a place acceptable to Engineer; keep place at ambient outdoor temperature.
 - a. Provide temporary shading.
 - b. Do not use covering causing temperature build-up.
- B. Handle into position to avoid damage in a manner acceptable to Engineer.

3.4 FIELD TESTING

- A. Perform hydrostatic and leakage tests in accordance with the applicable provisions of the Section entitled "Leakage Tests – Non-Structural", at the test pressure specified.

1. Clean pipe of dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.

* * * * *

SECTION 40 05 13.76

FRP DUCTWORK

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.
- B. Section 44 31 21 – Odor Control Systems

1.2 SUMMARY

- A. Furnish and install fiberglass reinforced plastic (FRP) ducts where indicated and of sizes shown on Drawings.

1.3 QUALITY ASSURANCE

- A. Equipment and materials provided under this Section shall be the standard product in regular production by manufacturers who shall have at least five years experience in the design and fabrication of the equipment as described herein, used for similar applications and shall have at least five installations in satisfactory operation.

1.4 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:
 - 1. FRP Ductwork

1.5 SUBMITTALS

- A. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:
 - 1. Manufacturer's literature, illustrations, specifications, and engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.
 - 2. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor non-conformities, and detailed explanation of other non-conformities.
- C. Submit Operations and Maintenance Manuals in accordance with the General and Supplementary Conditions.

- D. Submit Manufacturer's Certificate in accordance with the General and Supplementary Conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The design has been based on equipment provided by the following Manufacturers:
 - 1. Perry Fiberglass Products, Inc.
 - 2. Viron Internation Corp.
 - 3. or approved equal

2.2 SYSTEM COMPONENTS

- A. Ductwork shall be fiberglass reinforced plastic suitable for service in a saturated hydrogen sulfide atmosphere.
- B. Ductwork shall be designed and fabricated in accordance with National Bureau of Standards, Voluntary Product Standard PS 15-69, Custom Contact-Molded Reinforced Chemical-Resistant Process Equipment. Minimum physical properties shall be in accordance with Table 1 of PS 15-69, and minimum duct thickness and other dimensions shall be in accordance with Table 2 of PS 15-69. Ductwork shall be designed for 10 inches w.c. in accordance with Tables 1, 2, and 3 of PS 15-69. Filament wound duct shall conform with ASTM D3299.
- C. Fiberglass duct shall be fabricated with a premium vinylester resin, or brominated or halogenated polyester resin to provide Class II flame spread rating (30 or less) when tested in accordance with ASTM E84. The inner corrosion barrier shall be followed by not less than two (2) layers of 1-2 oz. chopped strand mat or two (2) passes of chopped roving to a total of 3 oz./sq. ft. The inner corrosion barrier plus the two (2) mat layers shall total 100 mils minimum and be approximately 27% (5% glass by weight) per ASTM D2584. No thixotropic agent shall be added. Exterior of duct shall have UV stabilizer.
- D. Flanged joints shall be used at all connections to equipment and at other locations as shown on the Drawings. Flanged joints shall utilized stainless steel bolts and 1/8-inch thick, full-face rubber gasket seals.
- E. Ells shall have a minimum centerline radius of 1.5 diameters. Elbows shall be smooth flow up to 24 inches in diameter. Mitres shall be allowed for elbows 24-inch and larger.
- F. Field fabricated joints shall be minimized to the extent possible. Duct sections shall be factory-fabricated and shipped in the largest possible sizes.
- G. The ductwork shall be designed with sufficient allowance for thermal expansion. Flexible connectors shall be provided as required, whether shown on the Drawings or not.

- H. Changes in duct sizes shall be made using tapered increasers or reducers.

2.3 DAMPERS

- A. Manual isolation dampers shall be of the slide gate type. Damper slides shall be solid plastic and shall be lockable in any position by a dial regulator. Metal components shall be of 316 series stainless steel.
- B. Balancing Dampers
 - 1. Balancing dampers shall be provided on each duct riser as shown on the Drawings.
 - 2. Dampers shall be flanged and drilled in accordance with NBS PS 15-69 standards. The damper shall be designed to withstand 10-inch w.c. pressure. Flange mount channel frame shall be vinylester with reinforced bearing pad. The blade thickness shall be as required by the damper Manufacturer. The bearings shall be molded synthetic. Fiberglass axles shall extend full length of blade and 6 inches beyond frame. The unit shall be equipped with a full circumference blade seal to limit leakage to less than 3 cfm/sq. ft. at 10-inch w.c. Leakage test and performance data shall be submitted from an AMCA approved testing laboratory. Metal components shall be 316 series stainless steel.
 - 3. Dampers shall be Belco Round Control Damper Model 203, or equal.
- C. Instrument test ports with removable caps shall be furnished at convenient locations in the ductwork near each balancing damper so that pressure and/or velocity may be determined in the ducts to enable initial and future balancing of the system.

2.4 FLEXIBLE CONNECTORS

- A. Flexible connectors shall be included in the FRP ductwork to dampen axial, lateral, and vibrational duct movement. A flexible connector shall be installed at each fan inlet and outlet, and at other locations as needed to accommodate thermal expansion.
- B. The flexible connector shall be constructed of fabric-reinforced rubber and shall be resistant to the corrosive gases being processed. It shall be able to withstand 15-inch w.c. The flexible connectors shall be flanged and drilled in accordance with PS 15-69 standards. The flexible connector shall be approximately 12 inches flange to flange. All bolts and hardware shall be stainless steel.
- C. The flexible connector shall be as manufactured by General Rubber, or equal.

PART 3 – EXECUTION

3.1 CLEANING

- A. Clean all ductwork before being placed in operation.

3.2 ADJUSTING AND BALANCING

- A. Completely adjust and balance the system to provide performance desired. Furnish the Engineer with copies of all instrument readings and air quantities leaving and entering units, in main trunks and duct risers, fan motor running amperage, and rated full load amps, etc. Air quantities shall be balanced to within 5% of those shown in Section 3.3.

3.3 SYSTEM BALANCING

LOCATION	DESIGN AIR FLOW RATE (CFM)		
Influent Chamber	225		
Upper Screw Pump Chamber #1	2964	or	0
Upper Screw Pump Chamber #2	0	or	2964
Bar Screen #1	250		
Bar Screen #2	250		
Effluent Chamber	15		
Grit Tank #1	455		
Grit Tank #2	455		
Fine Screen #1	257	or	0
Fine Screen #2	0	or	257
Fine Screen Dumpster #1	65		
Fine Screen Dumpster #2	65		
Total	5000		

SECTION 40 05 14

PIPELINE INSTALLATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- A. Contractor shall store and protect equipment specified herein in accordance with the requirements of Division 01.

1.2 SUMMARY

- A. This Section includes requirements for all metallic and non-metallic pipe, fittings and specials of the type and quality as shown in the Contract Drawings and as specified for the pipe.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society of Testing and Materials (ASTM)
 - 2. American Water Works Association (AWWA)

1.4 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions and Division 01, the following items shall be submitted:
 - 1. Test reports, certifications, shop drawings and samples are required as set forth in the Sub-section entitled "Submittals" in the specification Section for the type of pipe to be installed.
 - 2. Layout drawings are required for pipelines to be installed within structures showing the location including the support system, fittings, sleeves, wall castings and appurtenances.
 - 3. Layout drawings are required for all yardpiping showing the location including fittings and joint restraint systems.

PART 2 PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

A. Pipe

1. Materials for the piping, joints and fittings shall be as specified in the Section for the type of pipe to be installed or as shown in the Contract Drawings.
 - a. Pipe and appurtenances shall comply with the applicable standards for its type of material.

B. Joints

1. Type of joints shall be as shown or noted on the Contract Drawings.
2. Grooved and shoulder type joints of the rigid design may be used in lieu of flanged joints on ductile iron or steel pipe, only with the prior acceptance of the Engineer and only for pipe sizes acceptable to the Engineer.

PART 3 EXECUTION

3.1 INSPECTION

- A. Pipe and appurtenances shall be inspected by the Contractor in the presence of the Engineer on delivery and prior to installation for conformance with the standards and specifications.
1. Materials not conforming to the standards and specifications shall not be stored on site but removed at once and replaced with material conforming to the specifications.

3.2 INSTALLATION - UNDERGROUND

A. General

1. Excavation and backfilling shall be in accordance with the applicable provisions of the Section entitled "Trenching, Backfilling and Compacting".
2. Blocking will not be permitted under pipe, except where the pipe is to be laid with concrete cradle or encasement.
3. No pipe shall be laid upon a foundation in which frost exists; nor at any time when there is danger of the formation of ice or the penetration of frost at the bottom of the excavation.
4. Temporary bulkheads shall be placed in all open ends of pipe whenever pipe laying is not actively in process. The bulkheads shall be designed to prevent the entrance of dirt, debris or water.
4. Precautions shall be taken to prevent the flotation of the pipe in the event of water entering the trench.

B. Location and Grade

1. Pipelines and appurtenances shall be located as shown on the Contract Drawings or as directed and as established from the control survey in accordance with the Supplementary Conditions.
2. The alignment and grades shall be determined and maintained by a method acceptable to the Engineer.
3. Contractor shall document pipe invert elevations and provide elevation information to Engineer for inclusion on Record Drawings.

C. Subgrade

The subgrade for pipelines shall be earth or special embedment as specified or directed and shall be prepared in accordance with the Section entitled "Trenching, Backfilling and Compacting".

D. Joints

1. Joints shall be assembled using gaskets, lubricants and solvents as furnished by the pipe manufacturer and in accordance with the manufacturer's recommendations.

E. Embedment

1. Embedment shall be deposited and compacted in accordance with the Section entitled "Trenching, Backfilling and Compacting", and the Section for the type of pipe being installed and shall be one of the embedments shown below unless otherwise specified or directed.

2. Type "A" Embedment

Pipe of	Cast Iron Soil
	Copper
	Corrugated Steel
	Ductile Iron
	Reinforced Concrete
	Vitrified Clay
	Wrought Steel.

- a. The embedment shall be native material excavated from the trench, which is acceptable to the Engineer, containing no stones larger than 1-1/2 inches in size or debris.
- b. It shall be deposited and tamped in 6-inch layers to the centerline of the pipe.

- c. Native material placed above the centerline of the pipe to a depth of 12 inches above the pipe shall be deposited in such manner as to not damage the pipe.
- d. When shown on the Contract Drawings, or when directed by the Engineer, Select Fill material shall be used in lieu of the native material for a) or c) above.
- e. Apply this specification to ductile iron pipe 16-inches and smaller.
- f. For ductile iron pipe greater than 16-inches refer to details shown on the Contract Drawings.
 - 1) Granular bedding shall consist of compacted AASHTO M43 Size #57 granular material. Material is specified in the Section entitled "Select Fill".
 - 2) The backfill shall be native material excavated from the trench, when acceptable to the Engineer, containing no stones larger than 1-1/2 inches in size or debris.

3. Type "B" Embedment

Pressure Pipe of

Fiberglass (FRP)
Polyvinyl Chloride (PVC)
High Density Polyethylene (HDPE)
Polyethylene (PE)
Steel
Thermal Plastic

- a. The embedment shall consist of compacted AASHTO M43 Size #57 granular material placed from a depth of 6" below the pipe to the centerline of the pipe. Select material is specified in the Section entitled "Select Fill."
 - 1) It shall be deposited and hand-compacted in 6-inch maximum layers.
- b. From the centerline to the top of the pipe the embedment shall be native material excavated from the trench, which is acceptable to the Engineer, containing no stones larger than 1-1/2" in size and shall be lightly compacted.
- c. From the top of the pipe to one foot above the pipe, acceptable native material shall be deposited in such manner as to not damage the pipe.
- d. When the native material under b) or c) above is not acceptable, to the Engineer, Select Fill materials shall be used.

- e. Metal Detection tape should be installed 12-inches below grade along centerline of pipe.

4. Type "C" Embedment

- Non-pressure pipe of Fiberglass (FRP)
 Polyvinyl chloride (PVC)
 High Density Polyethylene (HDPE)
 Polyethylene (PE)
 Thermal Plastic
- a. The embedment shall consist of compacted AASHTO M43 Size #57 granular materials placed from a depth of 6" below the pipe to a depth of 12" over the pipe. Select material is specified in the Section entitled "Select Fill."
 - 1) It shall be deposited and hand-compacted in 6-inch maximum layers.
 - b. Backfill under a) above shall be native material excavated from the trench, which is acceptable to the Engineer, containing no stones larger than 1-1/2 inches in size or debris.
 - c. When the native material under b) above is not acceptable to the Engineer, Select Fill materials shall be used.
 - d. Metal Detection tape should be installed 12-inches below grade along centerline of pipe.

F. Thrust Restraints

- 1. Pressure pipelines shall have thrust restraints in the form of restrained joints or anchors of the size and type specified or as required by the pressure and stability of the supporting surface. Thrust blocks will not be allowed unless specifically indicated in the Contract Documents, or as directed by the Engineer.
 - a. Thrust restrain shall be installed at all changes in direction, changes in size, dead ends, tees, or other locations where shown or specified in the Contract Documents.
 - b. Thrust restraints shall be in place, and when of concrete as specified in Section entitled "Cast-in-Place Concrete" shall have developed the required strength, prior to testing of the pipeline.
 - c. Tie rods and nuts for thrust restraints shall have a minimum yield strength of 70,000 psi.
 - 1. Exposed tie rods and nuts shall be stainless steel.

2. Tie rods and nuts installed underground shall be of high tensile steel and coated with two coats of coal tar pitch preservative coating after installation.

d. Restrained joints shall be manufactured by one of the following:

1. TR Flex by U.S. Pipe
2. Lok-Fast by American Ductile Pipe
3. Megalug by EBAA Iron, Inc.

G. Service Connections

1. Connections to in-service pressure pipelines shall be in accordance with the applicable provisions as specified on the Contract Drawings.
2. Connections to sewers shall be saddle, wye or tee branches as specified.
 - a. Saddle and wye branches shall be installed, in general, so that the top of the branch is at the top of the pipe.
3. Laterals of the kind and size of pipe as specified shall be installed as shown, specified or directed.
 - a. Bends, as required, shall be used between the connection and the lateral, to obtain the correct slope and to allow the horizontal angle of the lateral to be at 90 degrees to the main line or other angle as specified or directed.
 - b. Minimum slope for a lateral shall be 1/4 inch per foot.
 - c. Maximum slope for a lateral shall be 2 feet per foot unless otherwise specified.
 - d. Each lateral having a slope of 1 foot per foot or greater shall have a concrete cradle. Concrete shall be placed 6" each side of and from a depth 3" below to the centerline of the lateral pipe.
 - e. Laterals specified to exceed the maximum slope shall be supported to prevent excessive load being applied to the main line pipe and shall be encased in a minimum of 6 inches of Class B air-entrained concrete.
 - f. The end of each connection or lateral shall be sealed by means of a removable watertight plug as shown on the Contract Drawings.
 - g. The end of each connection or lateral shall have a 2 x 4 inch marker extending vertically from the stopper to 3 feet above the ground surface. The portion of the marker extending above the ground shall be painted green.

4. Connections and ends of laterals shall not be backfilled until a record has been made of the "as-built" location of each.

H. Connection to Existing Structures or Manholes

1. Where a stub has been provided the connection shall be made to the existing pipe.
2. Where no stub has been provided, the Contractor shall make an opening for inserting the connecting pipe.
 - a. When specified, a sleeve shall be installed and a watertight joint formed.
 - 1) The carrier pipe shall be installed in the sleeve and the joint made watertight.
 - b. Where no sleeve is specified, the space between the pipe and the wall of the structure or manhole shall be made watertight.
 - c. A joint shall be in the pipe at or within 5 feet of a structure or manhole.
 - d. A channel shall be built or the existing channel revised, to direct the flow from or into the new pipe.
 - e. Care shall be taken to avoid damage to the existing structure or manhole and to prevent debris from entering any existing channel. Any damage shall be repaired and debris removed.

I. Tracer Wire

1. To allow tracing of non-metallic pipe, the Contractor shall pull a continuous detection wire along all non-metallic pipe prior to backfilling, or provide placement of such a wire by other approved methods.
2. The detection wire shall be unshielded copper wire (#6 minimum).
3. Extend the wire at structures a sufficient length to allow each end to extend to above grade at each structure.
4. It shall be the Contractor's responsibility to test the wire for continuity to ensure that the detection wire is electrically continuous between structures.

3.3 INSTALLATION - EXPOSED

- A. Exposed pipelines shall be carefully erected and neatly arranged.
 1. Run parallel to wall of structures

- B. Supports and anchors shall be adequate to support the pipe filled with water with a minimum safety factor of 5 and for the test pressure specified.
- C. Special supports shall be as specified in the Section for the type of pipe being installed.

3.4 FINAL INSPECTION OF SEWERS

- A. Each section of pipe between manholes shall be inspected before final acceptance.
 - 1. In larger pipelines the inspection shall be by traversing the inside of the pipe.
 - 2. In smaller pipelines the inspection shall be by observation with camera.
 - 3. Where specified, the inspection shall be by closed circuit television and shall be monitored by both the Engineer and the Contractor.
- B. The inspection shall determine the pipeline to be true to line and grade, to show no leaks, to have no obstruction to flow, to have no projections or protruding of connecting pipes or joint materials, shall be free from cracks and shall contain no deposits of sand, dirt or other materials.
- C. All deficiencies located during the inspection shall be corrected.

3.5 CUTTING AND SPECIAL HANDLING

- A. Field cuts of pipes shall be in accordance with the manufacturer's instructions.
- B. Where a pipe requires special handling or installation it shall be in accordance with the Section for that type of pipe.

3.6 FLEXIBLE COUPLINGS

Flexible couplings (including solid sleeve type "Dresser" coupling) shall be provided where shown or specified and shall be in accordance with the Section entitled "Flexible Pipe Couplings". Where such couplings are shown below grade, the couplings provided shall be designed and manufactured specifically for buried use.

3.7 WALL CASTINGS AND SLEEVES

All pipelines passing through walls, floors or slabs of structures shall be installed in a wall casting or sleeve. The wall castings and sleeves shall be in accordance with the Section entitled "Wall Castings and Sleeves" and as indicated on Contract Drawings.

3.8 LEAKAGE TEST

- A. All pipelines shall be tested for leakage in accordance with the Section entitled "Leakage Tests – Non Structural".

3.9 TRANSITION COUPLING

- A. DIP to SDR 35 PVC Non-Pressure Pipe – Provide RCDP for Ductile Iron Pipe by DR35 Sewer Pipe by Ford Meter Box Company or approved equal.

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SECTION 40 05 23.01

GATE VALVES THREE INCHES AND LARGER

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for gate valves three inches and larger as indicated in accordance with the Contract Documents.
- B. Solid wedge resilient seated valves shall be installed, unless otherwise specified.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Water Works Association (AWWA)

1.4 SUBMITTALS

- A. Shop Drawings

Prior to delivery of any gate valves, submit detail drawings and description of each size valve including materials of construction and parts lists.
- B. Affidavit of Compliance

Submit the manufacturer's affidavit stating the valves comply with all applicable provisions of the AWWA Standards and this specification.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Gate valves shall be furnished by manufacturers whose product conforms to the requirements of the AWWA Standards and this specification.
- B. Gate valves of like size shall be by the same manufacturer.

2.2 VALVE CONSTRUCTION

A. Standards

1. Resilient seated AWWA C509.
3. Valves shall be designed for a minimum working pressure of 100 psi or the maximum pressure of the pipe in which the valve is to be installed, whichever is higher.
4. Gate valves 12" and smaller with working pressure of 50 psi to 200 psi and 16" and larger with specified working pressure of 50 psi to 150 psi shall conform to the requirements of AWWA Standards. Gate valves of sizes or pressure classes outside of the above ranges shall conform to manufacturer's standards with materials and construction conforming to the AWWA Standards as applicable.

B. General Design

1. Unless otherwise indicated in the Contract Documents, gate valves shall be:
 - a. Non-rising stem
 - b. Dual O-ring stem seal
 - c. Counterclockwise direction of opening
2. Gate valves larger than 12 inches installed horizontally in a horizontal pipeline shall be equipped with bronze rollers, non-corrodible tracks, and bronze scrapers.
3. Bronze Grade B or C shall not be used in valve construction.

C. Valve Joints

Where the joint is not scheduled or shown, the joint shall conform to the type of pipe joint at point of installation.

D. Tapping Sleeves and Valves

Valves shall comply with provisions of AWWA Gate Valves for operational and hydrostatic tests.

2.3 ACCESSORIES

A. Gearing

1. Gearing shall be installed on all gate valves larger than 12 inches.
2. Gear ratios shall conform to AWWA Standards.
3. Gear cases on valves installed in the ground shall be of the extended type and stem seal shall be protected by a shield to prevent contact of these parts with soil.

4. Exposed non-rising stem valves with gearing shall have position indicators, unless otherwise scheduled.

B. Bypass

1. If called for on the Contract Drawings, gate valves 16 inches and larger shall be equipped with bypass and bypass valve, and shall be sized in accordance with AWWA Standard.
2. Bypass valve shall conform to the provisions of this Section.

C. Operators

1. Valves installed in the ground shall be fitted with standard wrench nuts and position indicators.
2. Valves installed exposed shall be fitted with lever and crank, floorstand, motor operator, hydraulic or other operator as indicated.
3. Valves installed greater than 5 feet above an operating floor, without specified operator, shall have a chainwheel operator with chain extending to 4 feet above the operating level and hook to clips arranged to clear walking aisles.
4. Operators shall be supplied with a cast arrow showing the direction of valve opening.

D. Extension Stems

1. Valves scheduled or shown and valves installed in the ground with the operating nut greater than 4 feet below the finished grade shall have extension stems.
2. Valves in the ground shall have the stems extended to within 3 feet of the finished grade.
 - a. A centering device shall be installed on the extension stem just below the extended operating nut.

E. Valve Boxes

1. Valves installed in the ground shall be equipped with an adjustable type valve box.
2. The valve box shall have a barrel not less than 5 inches in diameter and with a base to fit the valve on which it is to be installed.
3. The valve box cover shall indicate by means of a cast arrow the direction of valve opening.

4. Where applicable, the word "Water" or "Sewer" shall be cast in the valve box cover.

F. Tapping Sleeves and Valves

1. Valves and tapping sleeves shall be mechanical joint and designed for an operating pressure equal or greater than that of the installation pipe.
2. Valves shall have 2-inch operating nut and valve box suitable for 42-inch bury.
3. Valves and tapping sleeves shall be of cast or ductile iron construction.
4. Valves shall have non-rising stems.
5. Valve stem shall be bronze and O-rings shall be provided to provide seal between stem and bonnet.
6. Bolts shall be stainless steel for corrosion resistance.

2.4 SHOP PAINTING

- A. Valve shall be shop coated with asphalt varnish in accordance with AWWA Standards.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The installation of valves shall be to the configuration shown on the Contract Drawings, Shop Drawings and in accordance with the manufacturer's recommendations.
- B. Valves shall be supported independently from the equipment and pipeline on supports approved by the Engineer.

3.2 FIELD PAINTING

- A. The field painting of all valves shall be in accordance with the painting specified for the pipeline into which the valve is installed.
- B. Prior to applying a paint or coating the valve shall have applied a minimum of one coat of Inertol "tar stop", or approved equal, to cover the asphalt varnish shop coating or sandblasted as specified in the Section entitled "Painting", before additional coats are applied.

3.3 FIELD TESTING

- A. Upon completion of the installation, the Contractor shall operate all valves to show they operate without binding or strain.

- B. Any deficiencies in the valves or installation shall be corrected.

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SECTION 40 05 23.02

CHECK VALVES THREE INCHES AND LARGER

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing check valves three inches and larger as indicated in accordance with the Contract Documents.

1.3 REFERENCES

- A. All materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein.
 - 1. American National Standards Institute (ANSI)
 - a. B16.1 – Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
 - 2. American Society for Testing and Materials (ASTM)
 - a. ASTM A126 – Gray Iron Castings for Valves, Flanges and Pipe Fittings
 - 3. American Water Works Association (AWWA)
 - 4. National Electrical Manufacturers Association (NEMA)

1.4 SUBMITTALS

- A. Shop Drawings
 - 1. Prior to obtaining any equipment in connection with this Section, the Contractor shall submit detailed drawings and descriptions of all valves.
 - 2. Shop drawing data shall include materials of construction list and complete parts list.
 - 3. Submittals for electric check valves shall include manufacturer's catalog information, clearly marked or noted with specific features, standard

options, and wiring diagrams to indicate compliance with Contract Documents.

4. Submit detailed catalog data and mounting details of valve position limit switches.
5. Submittals for electrical equipment and materials shall include manufacturer's catalog information which shall be clearly marked or noted with specific features, standard options, and wiring diagrams to indicate compliance with Contract Documents.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 1. DeZurik
 2. Val-Matic
 2. Clow
 3. Or approved equal

2.2 GENERAL

- A. Check valves shall prevent the return of process fluid back through the valve when the inlet pressure decreases below the delivery pressure.
- B. Where shown, specified or required for proper function, check valves shall be provided complete with special levers, weights, springs, dash pots and appurtenances.
- C. Valves of like size and type shall be furnished by the same manufacturer.
- D. Where the joint is not specified or shown, the joint shall be as required to conform to the type of pipe joint at the point of installation.

2.3 WATER AND SEWAGE (LIQUID) SERVICE

- A. General
 1. Check valves shall be designed for either a minimum working pressure of 100 psi or the maximum pressure of the pipe in which the valve is to be installed, whichever is higher.
 2. Swing check valves shall be provided, unless otherwise specified or shown.
- B. Swing Check Valves

1. Swing check valves shall have heavy ASTM A126 Class B cast iron or ASTM A216 Class WCB cast steel body, with bronze or stainless steel ring, a non-corrosive stainless steel pivot shaft, and outside adjustable lever and weight.
2. The valve shall be tight seating, and shall operate without hammer and shock through an oil cushion chamber or adjustable spring mechanism. The seat ring shall be renewable and shall be securely held in place by a threaded joint.
3. Valves shall be as manufactured by GA Industries Inc., M&H Valve, DeZurik/Apco or approved equal.

C. Ball Check Valves

1. Ball check valve shall have ASTM A126 cast iron body, with bolted cover. Ball shall be ASTM A126 cast iron with vulcanized Buna-N rubber coating. Flanges shall be cast iron drilled to match ANSI B16.1 Class 125 Standard. Valve shall be rated at 150 psi at 150 degrees F.
2. Valve shall have integrally cast smooth ribs in the housing wall to guide the ball to and from its seat. Interior of the valve housing shall be designed to allow free and unobstructed flow with no projections or pockets to trap solid material. Valve shall be equipped with sinking ball. Positive seating shall be ensured without the use of springs or other mechanical means.
3. Valves shall be as manufactured by GA Industries Inc. (Figure 240), or approved equal.

D. Tilting Disc Check Valves

1. Tilting disc check valves shall conform to manufacturer's standards with materials and construction conforming to the requirements of AWWA C508 as applicable.
2. Tilting disc check valves shall not be installed on sewage service piping; acceptable applications are limited to "clean water" service only.

E. Flanged Elastomeric Duckbill Check Valves

1. Elastomeric duckbill check valves shall be one piece construction with nylon reinforcement. Valve material shall be neoprene rubber unless otherwise indicated.
2. Valve port shall transition from round to linear slit in a duckbill geometry, which shall allow passage of flow in one direction while preventing reverse flow.
3. Valves for flanged joint connection shall have integral, all-rubber flange in conformance with ANSI drillings, and shall be furnished with stainless steel back-up rings for installation.

4. Valves shall be designed for 1-psi differential pressure unless otherwise indicated.
5. Valves shall be as manufactured by Red Valve Co., Inc. (Series 35), Elasto-Valve Rubber Products Inc., or approved equal.

F. In-Line Elastomeric Duckbill Check Valves

1. Valve body shall be a two piece split configuration, of cast iron. Rubber sheet gaskets, cut to match the profile of the body halves, shall seal the two halves. The flanges shall be drilled to mate with ANSI B16.1, Class 125/ ANSI B16.5 Class 150 flanges, and port areas shall be 100% of the mating pipe port area. Valve body shall be drilled and tapped for a supplied clean out plug on the top of the body and flushing connections on the bottom of the body supplied with plugs.
2. The check sleeve is to be of the fabricated elastomer "duckbill" type. The sleeve shall be one piece rubber construction with fabric reinforcement. The inlet port shall have an integral flange, drilled to be retained by the flange bolts and acting as the gasket between pipe and valve. The flange will be drilled to ANSI B16.1, Class 125/ ANSI B16.5 Class 150 standards, and the inlet port area shall be 100% of the mating pipe port area. The port area shall contour down to a duckbill, which shall allow passage of flow in one direction while preventing reverse flow.
3. Manufacturer must have available flow test data from an accredited hydraulics laboratory to confirm pressure drop data. Company name and location shall be cast onto the valve body.
4. When line pressure inside the valve exceeds the backpressure outside the valve by a certain amount, the line pressure forces the bills of the valve open, allowing flow to pass. When backpressure exceeds the line pressure by at the same amount, the bills of the valve are forced closed.
5. Valves shall be Series 39 as manufactured by Tideflex Technologies, Inc. of Pittsburgh, PA or approved equal.

G. FLEXIBLE DISK CHECK VALVES

1. The check valve shall be of the full body type, with a domed access cover and only one moving part, the flexible disc.
2. The valves shall be designed, manufactured and tested in accordance with AWWA Standard ANSI/AWWA C508. The valves used in potable water service shall be certified to NSF/ANSI 61, and certified to be Lead-Free in accordance with NSF/ANSI 61, Annex G. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

3. The Valves shall be provided with flanges in accordance with ANSI B16.1, Class 125.
4. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4 in. (100mm) valve shall be capable of passing a 3 in. (75mm) sphere. The seating surface shall be on a 45 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator or oil cushion without special tools or removing the valve from the line. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator. The disc shall be of one-piece construction, precision molded with an integral o-ring type sealing surface, and contain alloy steel and nylon reinforcement in the flexible hinge area. The flex portion of the disc shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short disc stroke and a memory disc return action to provide a cracking pressure of 0.25 psig. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures.
5. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 class B for 30 in. (800mm) and larger. Optional body materials include ASTM A-351 Grade CF8M, stainless steel (sizes 3" (80 mm) through 12" (300 mm)). The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG. Optional disc material includes Viton.
6. Options: A screw-type backflow actuator shall be provided to allow opening of the valve during no-flow conditions. Buna-N seals shall be used to seal the stainless steel stem in a Lead-Free bronze bushing. The backflow device shall be of the rising-stem type to indicate position. A stainless steel T-handle shall be provided for ease of operation. A mechanical indicator shall be provided to provide disc position indication on valves 3" (80 mm) and larger. The indicator shall have continuous contact with the disc under all operating conditions to assure accurate disc position indication. A bottom mounted oil dashpot (oil cushion) shall be provided to provide hydraulic control of the final 10% of valve closure and reduce valve slam and water hammer normally associated with rapid flow reversal conditions on pump shut down. The dashpot shall consist of a high pressure hydraulic cylinder, adjustable external flow control valve, oil reservoir, pressure gauge, stainless steel air inlet valve, and piping designed to control the closing speed of the last 10% of travel in 1-5 seconds. A threaded brass dashpot bushing unit with a grease fitting for lubrication shall connect the cylinder to the valve and shall have an air gap to prevent hydraulic fluid from entering the valve and contaminating the water system. A snubber rod fitted with O-ring seals and rod wiper scrapers shall make contact with the lower portion of the disc's stainless steel strike plate.
7. Manufacturer shall demonstrate a minimum of five (5) years experience in the manufacture of resilient, flexible disc check valves with air and hydraulic

cushions. All valves shall be hydrostatically tested and seat tested to demonstrate zero leakage. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals. The exterior and interior of the valve shall be coated with an NSF/ANSI 61 approved fusion bonded epoxy coating.

8. Flexible Disk Check Valves shall be: Swing-Flex Series #500 by Val-Matic Valve & Mfg. Corp.; KenFlex Resilient Hinged Check Valve by Clow Valve Co; Mueller Figure 13.12 Flexible Disk Check Valve, or approved equivalent.

2.4 AIR SERVICE

- A. Check valves shall be of the wafer type, designed to fit between two ANSI B16.1 150-pound steel or cast iron flanges.
- B. Check valve shall have cast iron body, stainless steel pin, and two semi-circular bronze or aluminum discs. The valve body shall meet the requirements of ASTM A278 Class 40. The discs shall have silicone seals along the seating surface.
- C. Check valve shall have a centrally located vertical hinge pin. The valve shall be designed for tight shutoff under all reverse flow and head conditions. The valves shall be designed for a minimum working pressure of 125 psi.
- D. Valves shall be as manufactured by Techno Corporation, Merlin Valve Co., or approved equal.

2.5 SHOP PAINTING

- A. Valves to be field painted shall be shop primed with a primer compatible to the field painting specified in the Section entitled "Painting".

PART 3 EXECUTION

3.1 GENERAL

- A. The installation shall be to the configuration shown on the Contract Drawings, Shop Drawings and in accordance with the Manufacturer's recommendations.
- B. Valves shall be supported independently from the equipment and pipeline on supports approved by the Engineer.

3.2 FIELD PAINTING

- A. The field painting of all valves shall be in accordance with the painting specified for the pipeline into which the valve is installed.
- B. Valves painted with asphalt varnish shall be coated with a minimum of one coat of Inertol "tar stop" or approved equal or sand-blasted as specified in the Section entitled "Painting" before additional coats are applied.

3.3 FIELD TESTING

- A. Upon completion of installation, the Contractor shall operate all valves to show they operate without binding or strain.
- B. Any deficiencies in the valves or installation shall be corrected.

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SECTION 40 05 23.03

BUTTERFLY VALVES THREE INCHES AND LARGER

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing butterfly valves three inches and larger as indicated in accordance with the Contract Documents.

1.3 RELATED WORK

- A. Related Sections include the following:
 - 1. Division 9 Section "Painting"
 - 2. Division 40 Section "Electrically-Operated Primary Control Valves"

1.4 SUBMITTALS

- A. Submit the following Shop Drawings in accordance with Division 01.
 - 1. Shop Drawings including valve operator, gear ratio, performance charts, size, flow direction, joint, parts list, design flow and pressure differential, as required, for butterfly valves three inches and larger.
 - a. Catalog Data for butterfly valves.
 - b. Manufacturer's installation recommendations for butterfly valves.
 - 2. Submittals shall include electric actuator information as specified in the Submittals section of the specification entitles "Electrically-Operated Primary Control Valves". Submittal of the electric actuator shop drawings under a separate cover shall not be permitted.
 - 3. Submit a coordination list which identifies the purpose for each electrically operated valve. The coordination list shall include project specific information such as valve tag numbers, valve type, size, and application.
 - 4. The valve manufacturer shall submit written certification with the submittal of the valves that:
 - a. The electric actuator supplied with the valve has been coordinated with the valve operating requirements.

- b. The valve manufacturer has reviewed the electric actuator shop drawings, and the shop drawings have been coordinated with the valves so as to provide a completely functional and operational system.
 - c. Material test reports for pressure retaining components shall be kept on file, by the manufacturer, for a period of three years from the date of manufacture.
- 5. Submit Operation and Maintenance Manuals for butterfly valves in accordance with the General and Supplementary Provisions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 - 1. Cast or Ductile Iron Butterfly Valves
 - a. DeZurik
 - b. Keystone
 - d. Or approved equal

2.2 GENERAL

- A. Each valve operator shall be marked with an arrow and the words "OPEN" and "CLOSED". Each valve shall have position graduations equally spaced between "OPEN" and "CLOSED" position.
- B. All valves of the same type shall be from the same manufacturer. Parts of valves of the same type and size shall be interchangeable.
- C. All valves shall be carefully erected in their respective positions, free from all distortion and strain, and shall be packed and left in satisfactory operating condition.
- D. All valves shall be complete with operators as specified herein. Valves shall be tested, and coated as specified.
- E. Valves shall be of the lug body type, [unless otherwise indicated](#). Lugs shall be cast solid and faced accurately at right angles to the axis of the casting. Lug shall be faced, drilled, tapped and shop coated with a rust-preventive compound before shipment.
- F. Dimensions and drillings of lugs shall be designed to meet the requirements of ANSI B16.1 Class 125 flanges. The pressure-temperature ratings shall exceed the specified test pressure of the pipeline in which the valve is installed and shall not be less than Class 125. Special drillings shall be provided where required.

- G. The maximum force required to operate all manual valves, levers and cranks, and handwheels shall be 40 pounds. The overall length of each wrench or single-arm lever shall not exceed 18 inches.
- H. Butterfly valves shall be 125 psi gas pressure rated with resilient seats giving bubble-tight shutoff at temperatures up to 350 degrees F.
- I. The valve body shall be cast iron meeting the requirements of ASTM A126 Class B or ductile iron per ASTM A536. The disc shall be of ductile iron or electroless nickel coated cast iron, unless the valve will be used for air service in a fine bubble aeration system. Fine Bubble aeration service valves shall have a disc constructed out of 316 stainless steel meeting the requirements of API 609.
- J. Valve shall have a 416 stainless steel stem, self-lubricating bronze bearings at both ends, and Norel seats. When using a stainless steel disc, valves shall have a 316 stainless steel stem.
- K. Valves shall be designed to fit between two ANSI B16.1 150-pound steel or cast iron flanges.
- L. Motorized valve operators and positioners shall meet the requirements of the Section entitled "Electrically-Operated Primary Control Valves". Un-interrupted service (US) or offset disc resilient-seated butterfly valves shall be provided for modulating service valves. Modulating service valves shall be designed with the valve disc offset from the centerline of the valve to reduce wear from high throttling and high cycling applications. See Section 2.2.1 for a schedule of modulating service butterfly valves.
- M. Manually operated valves located seven feet or more above the operating floor shall have chains and chainwheel operators. Provide suitable hooks fastened to wall or other parts of the structure on which chains may be hung when not in use.
- N. Butterfly valves six inches and smaller shall be provided with a ten-position lever operator, unless specified otherwise. Butterfly valves greater than six inches shall be provided with a ten-position lever operator, unless specified otherwise.

2.2.1 SCHEDULE OF MODULATING SERVICE BUTTERFLY VALVES

Instrument Tag No.	Description
FCV-375	Oxic Butterfly Valves No. 1-3*, Modulate airflow to Oxic IFAS Zones
FCV-377	DeOx Butterfly Valves No. 1-3*, Modulate airflow to DeOx Zones
*Refer to Contract 1a. Valves supplied by the Owner (under Contract No. 1a), but installed by Contract No. 2	

2.3 VALVE OPERATORS (ELECTRIC ACTUATORS)

- A. Electric actuators shall be provided for valves as scheduled in the Division 40 Section entitled "Electrically-Operated Primary Control Valves" and shown on the

Drawings. Actuators shall meet the material, electrical, and control requirements of that section.

- B. The valve manufacturer shall be responsible for furnishing the valve operators. The valve operator shall be coordinated with and shall be compatible for operation with each valve supplied. The valve manufacturer shall be responsible for coordinating the specific requirements of the valve operators with the electric actuator manufacturer.

2.4 SHOP PAINTING

- A. Valves to be field painted shall be shop primed with a primer compatible to the field painting specified in the Section entitled "Painting".

PART 3 EXECUTION

3.1 INSTALLATION

- A. Valves shall be installed with all appurtenances required for a complete and satisfactory installation in accordance with the manufacturer's recommendations and AWWA standards.
- B. The Contractor shall be responsible for all coordination of work by each trade and for the proper and permanent location of all inserts, sleeves, hangers and supports required for his work.
- C. During construction, keep all ends of valves closed with caps, plugs or wooden flange covers to prevent dirt, building materials and foreign matter from entering.
- D. Verify all dimensions of valves, special castings, fittings, pipes, so that all of the piping will fit together properly and will conform to the arrangements as shown on the drawings. Select laying lengths of fittings to suit the equipment to which connections are to be made and the indicated dimensions on the drawings. All pipe and specials shall be accurate to the dimensions shown. Hubs, spigots and flanges shall be at right angles to the axis of the openings and openings shall be at the exact angle specified.
- E. Do not drill holes for anchors, supports, hangers, in portions of the structure which may affect the structural soundness of that portion unless permission from the Engineer is granted.
- F. Ream all threaded joint pipe free from burrs and keep it free of scale and dirt. Make all threads standards, tapered and clean cut. Leave not more than two threads exposed on completed thread joint. Threaded joints shall be made up with Teflon tape joint sealer. Provide threads in accordance with ANSI B2.1.
- G. Unless otherwise specified, connect pipe requiring threaded connections with ground joint unions. Provide flanged malleable iron unions where required in flanged pipe. The finish of all unions shall match the piping in which they are installed. Provide unions at equipment and where required to facilitate removal of piping or equipment.

- H. Unless otherwise indicated, all butterfly valves shall be installed such that the valve seat operating stem is vertical.

3.2 FIELD PAINTING

- A. The field painting of all valves shall be in accordance with the painting specified for the pipeline into which the valve is installed.
- B. Valves painted with asphalt varnish shall be coated with a minimum of one coat of Inertol "tar stop" or approved equal or sand-blasted as specified in the Section entitled "Painting" before additional coats are applied.

3.3 FIELD TESTING

- A. After installation, the Contractor shall operate all valves to show they operate without binding or strain.
- B. Any deficiencies shall be corrected at the Contractor's expense.

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SECTION 40 05 23.04

PLUG VALVES THREE INCHES AND LARGER

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing eccentric non-lubricated type plug valves three inches and larger, suitable for sewage and sludge applications, to be installed as indicated in accordance with the Contract Documents.
- B. This Section includes requirements for providing 3-way tapered type plug valves three inches and larger, suitable for sewage and sludge applications, to be installed as indicated in accordance with the Contract Documents.

1.3 QUALITY ASSURANCE

- A. Plug valves of like size shall be of a single manufacturer.
- B. All valves furnished under this section shall be furnished by manufacturers who have at least five years experience in the design, production, assembly, and field service of valves of like type, size, and materials.

1.4 SUBMITTALS

- A. Submit the following Shop Drawings in accordance with the General Conditions and Division 01.
 - 1. Shop Drawings, including valve operator, gear ratio, size, flow direction, joint, materials and parts lists, as required for plug valves three inches and larger.
 - a. Catalog Data for plug valves.
 - b. Manufacturer's installation recommendations for plug valves.
 - 2. Submittals shall include electric actuator information as specified in the Submittals section of the specification entitled "Valve Operators". Submittal of the electric actuator shop drawings under a separate cover shall not be permitted.
 - 3. Submit a coordination list which identifies the purpose for each valve. The coordination list shall include project specific information such as valve tag numbers, valve type, size, and application.

4. The valve manufacturer shall submit written certification with the submittal of the valves that:
 - a. The electric actuator supplied with the valve has been coordinated with the valve operating requirements.
 - b. The valve manufacturer has reviewed the electric actuator shop drawings, and the shop drawings have been coordinated with the valves so as to provide a completely functional and operational system.
- B. Submit Operation and Maintenance Manuals for plug valves in accordance with the General Conditions and Division 01.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 1. DeZurik (Series 100 for eccentric plug valves)
 2. Clow
 3. Or approved equal

2.2 VALVE CONSTRUCTION

- A. General
 1. Valves shall be designed for either a minimum working pressure of 150 psi or the working pressure of the pipe in which the valve is to be installed, whichever is higher. Each valve shall be given a hydrostatic and seat test at the minimum working pressure or greater.
 2. Port area of eccentric plug valves shall be at least 100 percent of connecting pipe area for valves up to 20 inches in diameter and at least 70 percent of pipe area for valves larger than 20 inches in diameter.
 3. Each valve shall have an indicator for the plug position and the direction of normal flow.
- B. Valve Bodies
 1. Shall be of semi-steel (nickel-chrome alloy) or ASTM A126 Class B cast iron.
 2. Valve ends shall conform to the joint of the pipeline in which it is being installed.
 4. Valves 3 inches and larger shall be of the bolted bonnet construction.

C. Valve Plug

1. Shall make contact with the seat only in the fully closed position.
2. Shall be of semi-steel, ASTM A126 Class B cast iron, ASTM A-48, Class 40 Cast Iron, or ASTM 536 Gr. 65-45-12 Ductile Iron, and with resilient facing. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft.

D. Valve Seat

1. Valves shall be furnished with a 1/8" welded overlay seat of not less than 90% pure nickel.
 - a. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Screwed-in seats shall not be acceptable.
 - b. The interference between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure.

E. Valve Seals

1. Shall be of the permanently lubricated, multiple v-ring type.
2. Shall be adjustable. Adjustable packing shall be Acrylonitrile-Butadiene (NBR) multiple V-ring type, with a packing gland follower. Packing gland shall permit inspection, adjustment or complete replacement of packing without disturbing any part of the valve or actuator assembly, except the gland follower. Non-adjustable packing or packing requiring actuator removal to replace the packing, is not acceptable.

F. Bearings

1. Bearings shall be metallic sleeve type and shall be of sintered, oil impregnated, permanently lubricated type 316 ASTM A743 Grade CF-8M. Grease Fittings Shall Be Provided In The Upper And Lower Body Bearing Journals.

G. Operators

1. Valves smaller than 6 inches and above ground shall be wrench-operated unless otherwise specified.
 - a. Furnish a wrench for each valve.
2. Valves 6 inches and larger and buried valves shall be gear-operated unless otherwise specified.
 - a. Unless other operators are specified or the valve is buried, each valve shall have right-hand crank operators with drill attachment.

3. Valves located more than 5 feet above the floor shall have chainwheel operators with chains to within 4 feet of floor and a minimum of 2 feet of chain below the chainwheel centerline. Chains shall be hooked to clips arranged to clear walking aisles.
4. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque and to provide seat adjustment to compensate for changes in pressure differential or flow direction change.
5. Valves installed in the ground shall be equipped with valve boxes and extension stems.
6. Motorized valve operators and positioners shall meet the requirements of the Section entitled "Electrically-Operated Primary Control Valves".

H. Extension Stems

1. Extension stems shall be connected to valve stems by bronze or cast iron couplings. Stems shall be turned and threaded straight and true, and work true and smooth and in perfect alignment throughout the lift of opening and thrust of closing the valve.
 2. The diameter of the extension stem at the base of the thread shall be ample to withstand all expected stresses without deformation.
 3. Extension stem guides shall be installed as wall brackets to support extension stems. They shall be fully adjustable, constructed of high strength cast iron, with a bronze bushing and installed at a distance which does not permit the stem to be unsupported through a length of no more than seven feet.
- I. All exposed nuts, bolts and washers shall be zinc-plated. Internal body and parts of the valve shall be coated with epoxy coating approved by EPA or NSF for contact with potable water.

2.3 VALVE OPERATORS (ELECTRIC ACTUATORS)

- A. Electric actuators shall be provided as scheduled in and that meet the requirements of the Section entitled "Electrically-Operated Primary Control Valves".
- B. The valve manufacturer shall be responsible for furnishing the valve operators. The valve operator shall be coordinated with and shall be compatible for operation with each valve supplied. The valve manufacturer shall be responsible for coordinating the specific requirements of the valve operators with the electric actuator manufacturer.

2.4 SHOP PAINTING

- A. Valves to be field painted shall be shop primed with a primer compatible to the field painting specified in the Section entitled "Painting".

PART 3 EXECUTION

3.1 INSTALLATION

- A. Plug valves shall be installed as indicated for the normal direction of flow.
- B. All eccentric plug valves shall be installed such that the plug is on the top or side of the valve when in the open position.

3.2 FIELD PAINTING

- A. The field painting of all valves shall be in accordance with the painting specified for the pipeline into which the valve is installed.
- B. Valves painted with asphalt varnish shall be coated with a minimum of one coat of Inertol "tar stop" or approved equal or sand-blasted as specified in the Section entitled "Painting" before additional coats are applied.

3.3 FIELD TESTING

- A. After installation, the Contractor shall operate all valves to show they operate without binding or strain.
- B. Any deficiencies shall be corrected at the Contractor's expense.

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SECTION 40 05 23.05

KNIFE GATE VALVES THREE INCHES AND LARGER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for knife gate valves three inches and larger as indicated in accordance with the Contract Documents.
- B. The work covered by this section includes furnishing all labor, equipment, and materials required to furnish and install all knife gate valves, including operators, boxes, and accessories, as specified herein, shown on the Drawings, or required for proper completion of the work under these Contract Documents.

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Prior to delivery of any knife gate valves, submit detail drawings and description of each size valve including materials of construction and parts lists.
- B. Affidavit of Compliance
 - 1. Submit the manufacturer's affidavit stating the valves comply with all provisions of this specification.

1.4 STORAGE AND PROTECTION

- A. Store and protect valves and accessories in accordance with the requirements of the valve manufacturer or as directed by the Engineer.
- B. Protect ends of flanged and mechanical joint valves with full size wooden baffles securely bolted to the valve ends. Size of baffles shall be at least equal to outside diameter of flange. Secure valves 24 inches in size and larger to a wooden skid to facilitate handling and storage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 - 1. Dezurik
 - 2. Wey Valve
 - 3. Or approved equal.

2.2 GENERAL

- A. Knife gate valves shall be of the flanged wafer type with outside stem and yoke and a metal-seated, knife-blade gate with a beveled edge designed to push aside or cut through solids in its path. Knife gate valve shall have full round port opening and shall have a working pressure of at least 125 psi in sizes 24 inches and smaller and 50 psi in sizes 30 inches and larger. Valves shall be capable of providing bi-directional, drip tight shutoff.
- B. Knife gate valves shall have a heavy, one-piece body and end flanges of steel or cast iron. Valves shall be lined throughout with stainless steel, including the chest and packing areas. Liner shall extend beyond flange to form raised face mating surface. Knife gate shall be of ground and polished stainless steel of sufficient thickness to resist deformation of rated pressure across the gate. A full circle, raised-face seat with machined gate jambs at the sides and bottom shall be provided to hold the gate and assure positive seating. Seat shall have a neoprene or BNA-N elastomer D shaped ring recessed into the face of the valve seat for a driptight shutoff. All wetted parts of the valve shall be of Type 304 stainless steel.
- C. Knife gate shall be sealed with a minimum of four rings of Teflon or neoprene-impregnated asbestos packing. Gland shall be of corrosion-resistant material or shall be specially coated for corrosion resistance. Gland bolts and nuts shall be stainless steel.
- D. A heavy, fabricated, angular steel yoke assembly with stainless steel rising stem and bronze yoke sleeve shall be provided on the valve. Valve shall be provided with handwheel operator or extension stem and floorstand as shown on the Drawings. Valves 20 inches and larger shall have a geared operator.
- E. Ends of the valve shall be flanged and shall be drilled to mate with 125-pound cast iron flanges per ANSI B16.1.
- F. All exposed bolts and nuts on buried or submerged valves and operators shall be brass or stainless steel for corrosion resistance. Exposed bolts and nuts on exposed valves and operators shall be of corrosion-resistant materials or shall be zinc or cadmium plated.

- G. All castings, regardless of material, shall be free from surface defects, swells, lumps, blisters, sandholes, or other imperfections.
- H. All valves shall have the name of the manufacturer, rated working pressure, and size of the valve cast upon the body or bonnet in raised letters. Alternately, the name of the valve manufacturer, rated working pressure, and size may be stamped on a stainless steel identification plate permanently attached to the valve body or bonnet.
- I. The direction of rotation of the operator to open the valve shall be to the left (counterclockwise), unless otherwise specified. Each valve body or operator shall have cast thereon the word OPEN and an arrow indicating the direction to open.
- J. Valve operators shall be of sufficient size and capacity to seat, unseat, and operate the valve under the maximum specified differential pressure. Where no maximum differential pressure is specified, the operator shall be designed for a differential pressure equal to the maximum working pressure of the valve. Additional allowances shall be made for the lubricating and/or scale-forming tendencies of the fluid. Valves and operating mechanisms shall be of the proper size and dimensions to fit the pipe connections thereto and shall be installed in the position and within the space shown on the Drawings.

2.3 MANUAL VALVE OPERATORS

- A. The following knife gate valves shall be furnished with manual operators:

	<u>Purpose/Location</u>	<u>Detail</u>
1.	42-inch Flow Retention Basin Effluent located in Fine Screen Building	Extension stem with floor stand and handwheel with geared operator

- B. Extension stems, valve boxes, and stem guides shall be furnished where shown, specified, or required for proper operation.
- C. All manual rotary and lever operators shall be capable of seating or unseating the valve disc under the most adverse conditions in the particular application with not more than an 80-pound pull on the handwheel or lever. Valve operators shall be capable of holding the valve in any position between fully open and fully closed without creeping or fluttering. Operators shall be provided with adjustable, mechanical, stop-limiting devices to prevent over-travel of the valve disc in the open and closed positions. Manual rotary and lever operators shall comply with all applicable requirements of AWWA C540, Sections 11.1, 11.2, and 11.3.

2.4 ELECTRIC VALVE ACTUATORS

- A. Electric actuators shall be provided for valves where indicated, and shall meet the requirements of the Section entitled "Electrically-Operated Primary Control Valves".

- B. The valve Manufacturer shall be responsible for furnishing the valve actuators. The valve actuator shall be coordinated with and shall be compatible for operation with each valve supplied. The valve Manufacturer shall be responsible for coordinating the specific requirements of the valve actuators with the electric actuator Manufacturer.

2.5 SPARE PARTS

- A. Furnish the following spare parts where applicable for the valves specified herein:
- | | | |
|----|-----------------------------|---------------------------------------|
| 1. | Stem packing | One set each type and size of valve |
| 2. | O-ring stem or shaft seals | One set each type and size of valve |
| 3. | Resilient seat or disc | One each type and size of valve |
| 4. | Shaft bearings or bushings | One set each type and size of valve |
| 5. | Gaskets | One set each type and size of valve |
| 6. | Special tool or seat wrench | One each required for valve servicing |
- B. Suitably protect spare parts against corrosion and impact to withstand long-term storage. All parts shall be clearly labeled and identified by manufacturer's name and number and the valve to which they belong.

2.6 SHOP PAINTING

- A. Valves to be field painted shall be shop primed with a primer compatible to the field painting specified in the Section entitled "Painting".

PART 3 - EXECUTION

3.1 FACTORY TESTS

- A. Test all valves at the point of manufacture for proper and unobstructed operation and for leakage and adequacy of design.
- B. Valves shall be given an operation test, a leakage test at rated pressure differential, and a hydrostatic test at two times rated pressure. During the hydrostatic test, there shall be no leakage through the metal, the end joints, or the shaft or stem seal, nor shall any part be permanently deformed. During the leakage test, leakage shall not exceed that permitted by ANSI B16.104, Class IV for metal seated valves and Class VI for resiliently seated valves.

3.2 INSTALLATION

- A. Install all valves in strict conformance with the Drawings and approved shop drawings and manufacturer's instructions.
- B. Install valves in such a way that operators and packing are easily accessible. Valves with field replaceable seats shall be installed with sufficient clearance to permit removal of valve bonnet and stem without removing valve from the line.

3.3 FIELD PAINTING

- A. The field painting of all valves shall be in accordance with the painting specified for the pipeline into which the valve is installed.

3.4 FIELD TESTING

- A. Following installation, test all valves under the anticipated operating conditions. The ability of the valves to operate properly without leakage, binding, sticking, fluttering, or excessive operating torque shall be demonstrated to the satisfaction of the Engineer. At Contractor's expense, adjust and/or replace any valve as necessary to ensure satisfactory operation.

SECTION 40 05 23.06

PINCH VALVES THREE INCHES AND LARGER

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing pinch valves three inches and larger, suitable for sewage and sludge applications, as indicated in accordance with the Contract Documents.

1.3 QUALITY ASSURANCE

- A. All pinch valves shall be from a single manufacturer.
- B. All valves furnished under this Section shall be furnished by manufacturers who have at least five years experience in the design, production, assembly, and field service of valves of like type, size, and materials.

1.4 SUBMITTALS

- A. Submit the following Shop Drawings in accordance with the General Provisions.
 - 1. Shop Drawings including valve operator, gear ratio, performance charts, size, flow direction, joint, parts list, design flow and pressure differential, as required, for pinch valves three inches and larger.
 - a. Catalog Data for pinch valves.
 - b. Manufacturer's installation recommendations for pinch valves.
 - 2. Submittals shall include electric actuator information as specified in the Submittals section of the specification entitles "Valve Operators". Submittal of the electric actuator shop drawings under a separate cover shall not be permitted.
 - 3. Submit a coordination list that identifies the purpose for each electrically operated valve. The coordination list shall include project specific information such as valve tag numbers, valve type, size, and application.
 - 4. The valve manufacturer shall submit written certification with the submittal of the valves that:
 - a. The electric actuator supplied with the valve has been coordinated with the valve operating requirements.

- b. The valve manufacturer has reviewed the electric actuator shop drawings, and the shop drawings have been coordinated with the valves so as to provide a completely functional and operational system.
- B. Submit Operation and Maintenance Manuals for pinch valves in accordance with the General Provisions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 - 1. Red Valve Company, Inc. (Series 75)
 - 2. Larox Valve
 - 3. Or approved equal

2.2 VALVE CONSTRUCTION

- A. General
 - 1. Valves shall be designed for the following minimum working pressures:

4" – 6"	150 psi
8"	125 psi
12"	100 psi
16" – 30"	50 psi
 - 2. Each valve shall be given a hydrostatic test at twice the working pressure, or 150 psi, whichever is less. Coordinate testing with the Section entitled "Leakage Tests – Non-Structural".
- B. Valve Bodies
 - 1. Valve bodies shall be of ASTM A395 ductile iron or ASTM A48, Class 35B cast iron.
 - 2. Valves bodies shall be of the flanged body type. Flanges shall be cast solid and faced accurately at right angles to the axis of the casting. Flanges shall be faced, drilled, tapped and shop coated with a rust-preventive compound before shipment.
 - 3. Dimensions and drillings of flanges shall meet the requirements of ANSI B16.1 Class 150 flanges. Valves in sizes through 8" shall meet ANSI B16 face-to-face dimensions. In all sizes the valve length shall not exceed a ratio of two times the diameter to length. The pressure-temperature ratings shall exceed the specified test pressure of the pipeline in which the valve is installed and shall not be less than Class 125.

C. Valve Sleeve

1. Valve sleeves shall be of fabric reinforced Buna-N.
2. Valve sleeves shall be built with a minimum safety factor of 3:1.
3. Cone dimensions determined by manufacturer for each application.

D. Valve Stem

1. Valve stems shall be of 4140 carbon steel or 316 stainless steel.

E. Valve Pinch Rods

1. Valve pinch rods exposed to the environment shall be of stainless steel. Fully enclosed valve pinch rods shall be stainless steel or the manufacturers standard materials of construction.

2.3 VALVE OPERATORS

- A. Valves shall be lever and crank operated unless otherwise specified.
- B. Valves 6 inches and larger shall be gear-operated unless otherwise specified.
- C. Valves located more than 5 feet above the floor shall have chainwheel operators with chains to within 4 feet of floor and a minimum of 2 feet of chain below the chainwheel centerline. Chains shall be hooked to clips arranged to clear walking aisles.
- D. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque and to provide seat adjustment to compensate for changes in pressure differential or flow direction change.
- E. Electric Actuators
 1. Electric actuators shall be as scheduled in and meet the requirements of the Section entitled "Electrically-Operated Primary Control Valves".
 2. The valve manufacturer shall be responsible for furnishing the valve operators. The valve operator shall be coordinated with and shall be compatible for operation with each valve supplied. The valve manufacturer shall be responsible for coordinating the specific requirements of the valve operators with the electric actuator manufacturer.

2.4 SHOP PAINTING

- A. Valves to be field painted shall be shop primed with a primer compatible to the field painting specified in the Section entitled "Painting".

PART 3 EXECUTION

3.1 INSTALLATION

- A. Valves shall be installed as indicated for the normal direction of flow. All valves shall be installed such that the stem is in the vertical plane above the pipe when in the "OPEN" position.

3.2 FIELD PAINTING

- A. The field painting of all valves shall be in accordance with the painting specified for the pipeline into which the valve is installed.
- B. Valves painted with asphalt varnish shall be coated with a minimum of one coat of Inertol "tar stop" or approved equal or sand-blasted as specified in the Section entitled "Painting" before additional coats are applied.

3.3 FIELD TESTING

- A. Check valves for correct direction of flow, rated pressure and required body stampings.
- B. After installation, the Contractor shall operate all valves to show they operate without binding or strain. Operate all valves once through open/close cycle. Motor operated valves shall be operated twice. Valves shall operate freely.
- C. Any deficiencies shall be corrected at the Contractor's expense.

* * * * *

SECTION 40 05 23.07

MISCELLANEOUS VALVES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes valves 2-1/2 inches and smaller to be installed in pressure pipelines.
- B. This Section includes special valves and piping appurtenances of various sizes not specified elsewhere.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - a. B16.1 – Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
 - 2. American Petroleum Institute (API)
 - 3. American Society for Testing and Materials (ASTM)
 - a. ASTM A126 – Gray Iron Castings for Valves, Flanges and Pipe Fittings
 - b. ASTM B62 – Composition Bronze or Ounce Metal Castings
 - c. ASTM D1784 – Rigid PVC and CPVC Compounds
 - 4. American Society of Mechanical Engineers (ASME)
 - 5. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
 - a. MSS SP-80 – Bronze Gate, Globe, Angle and Check Valves
 - 6. United States Department of Defense Specifications and Standards

- a. A-A-59326 (MIL-C-27487) – Coupling Halves, Quick Disconnect, Cam-Locking Types

1.4 SUBMITTALS

A. Shop Drawings

1. Prior to obtaining any equipment in connection with this Section, the Contractor shall submit detailed drawings and descriptions of all valves.
2. Shop drawings shall include manufacturers catalog data and installation and maintenance recommendations for each valve and accessory type and application.
3. Shop drawing data shall include valve operator, gear ratio, performance charts, size, flow direction, joint, parts list, design flow and pressure differential as applicable.
4. The contractor shall submit all materials of construction and chemical compatibility charts for all valves and valve accessories to be used for chemical service.
5. Submit a coordination list which identifies the purpose for each valve. The coordination list shall include project specific information such as valve tag numbers, valve type, size, and application.

B. Electrical Submittal Information

1. Submittals for equipment and materials shall include manufacturer's catalog information which shall be clearly marked or noted with specific features, standard options, and wiring diagrams to indicate compliance with Contract Documents.
2. Submittals shall include electric actuator information as specified in the Submittals section of the specification entitled "Electrically-Operated Primary Control Valves". Submittal of the electric actuator shop drawings under a separate cover shall not be permitted.
3. The valve manufacturer shall submit written certification with the submittal of the valves that:
 - a. The electric actuator supplied with the valve has been coordinated with the valve operating requirements.
 - b. The valve manufacturer has reviewed the electric actuator shop drawings, and the shop drawings have been coordinated with the valves so as to provide a completely functional and operational system.

PART 2 PRODUCTS

2.1 GENERAL

- A. Valves 2-1/2 inches in diameter and smaller in metal pipelines shall be of all brass or bronze, except lever and cranks, unless otherwise indicated. Valves 2-1/2 inches in diameter and larger in metal pipelines shall have iron or steel bodies, unless otherwise indicated. Interior surfaces of metal valves in contact during the seating operation shall be either solid bronze or faced with bronze, unless otherwise indicated.
- B. Valves and valve parts used for chemical service or in a chemical environment shall be corrosion resistant to and suitable for use with the intended process chemicals. Valves for chemical service shall contain no metal in contact with flow.
- C. Valves 2-1/2 inches in diameter and smaller shall be provided with screwed ends unless otherwise indicated; provide soldered or welded joints where specified. Screwed pattern and solder pattern valves shall have a union adjacent to facilitate their removal. Valves located in flanged piping shall have flanged ends. Dimensions and drillings of flanges shall meet the requirements of ANSI B16.1. The flange pressure-temperature ratings shall exceed the specified test pressure of the pipeline in which the valve is installed and shall not be less than Class 125. Special drillings shall be provided where required.
- D. Valves shall be designed and rated for 150 psi working pressure, unless otherwise specified.
- E. Valves shall be equipped for nut, wrench or lever and crank operation, as shown or required and shall be equipped with extension stems, where necessary. Each valve shall be supplied with a lever and crank or wrench as required. All manually operated valves shall open by turning to the left (counterclockwise). Each valve lever and crank shall be marked with an arrow and the word "OPEN". Each nut shall be marked with an arrow.
- F. Each valve shall have the name of the manufacturer and the size of the valve cast on the body or bonnet in raised letters.
- G. All valves of the same type shall be from the same manufacturer. Parts of valves of the same type and size shall be interchangeable.

2.2 AIR RELEASE AND AIR/VACUUM VALVES

- A. General
 - 1. Air release and air/vacuum valves shall be designed for float activated air release. All internal valve components shall be corrosion-resistant; floats and float stems shall be stainless steel.
 - 2. Air release and air/vacuum valves for sewage service shall have elongated bodies to minimize process fluid contact with the air release outlet.

3. Contractor shall coordinate air release and air/vacuum valve selection with valve manufacturer, and manufacturer of equipment served (pump, meter, etc.) where applicable, for each valve location required. Air release and air/vacuum valves for applications not specifically described herein shall be per manufacturer's recommendations. Submit documentation of manufacturer coordination with valve shop drawings.
4. For air release valves in interior locations, air blow-off outlet shall be piped to floor drain or wet well served.
5. All valves shall be supplied with an isolation valve to isolate the air valve from the service. For sizes up to 3" NPT, a GA Figure 20 (or approved equal) bronze ball valve shall be furnished. For sizes 4" and up with a flanged connection, provide a GA Figure 30 (or approved equal) lugged butterfly valve.

B. Air Release Valves For Sewage Service

1. Sewage Air Release valves shall be designed to enable the valve to automatically release accumulated air and gases from a sewage pipeline while the system is pressurized and operating.
2. The Sewage Air Release Valves shall close drop tight, incorporating an adjustable Buna-N orifice button. All internal parts shall be of stainless steel. Body shall be cast iron conforming to ASTM A126, Class B. Inlet and outlet connections shall be NTP for valves 3" and less, FLG for valves 4" or greater.
3. If specified, the valve shall be supplied with a "Backflush Attachment" consisting of bronze shut-off valves, quick-connect couplings and rubber hose, for back washing with clean water.
4. If specified, the valve shall be supplied with a vacuum check on the outlet to prevent air from re-entering the system during negative pressure conditions.
5. The Sewage Air Release Valves shall be as manufactured by GA Industries Inc. (Figure 925), Crispin Valve (SL Series), Val-Matic, or approved equal.
6. If specified, a short-body style valve shall be provided, as manufactured by GA Industries Inc. (Figure 929), Crispin Valve, Val-Matic, or approved equal.
7. Schedule

Provide valve assemblies of this type as indicated in the Contract Documents, including but not limited to the following:

<u>Inlet / outlet / orifice</u> (in)	<u>Location</u>	<u>Equipment Served</u>	<u>Notes</u>
2.0/0.5/0.3125	Exterior, PEPS Building	PEPS Discharge Header	Stainless Steel Construction, Discharges outside
Notes: 1) All for sewage service 2) Provide vacuum check 3) Provide backflush attachment 4) Dimensions on drawings are based on Val-Matic model 48AS.4			

C. Air/Vacuum Valves For Sewage Service

1. Sewage Air / Vacuum valve shall be designed to automatically exhaust controlled quantities of air at pump start-up and allow air to re-enter during draining or when negative pressure occurs.
2. Valve shall be complete with an isolation valve (between the air release valve and the process line) and a throttling device installed on the outlet to allow control of the air discharge rate and pressure and column ascent rate. Valve shall be designed for closure without water hammer or damage to the system.
3. Provide a backflushing attachment to allow periodic flushing of sediment, grease, and solids from the valve.
4. Valve shall be as manufactured by GA Industries Inc. (Figure 935), Crispin Valve (SA Series), Val-Matic, or approved equal.

D. Single Body Combination Air Valve For Sewage Service

1. Sewage Combination Air Valve shall be designed to automatically exhaust controlled quantities of air from the pipeline at pump start-up as the pipeline fills, and allow air to re-enter during draining or when negative pressure occurs.
2. Sewage Combination Air Valve shall have standard, elongated bodies suitable for sewage service; short body design will not be acceptable unless otherwise prohibited by installation space available or called out on the Contract Drawings.
3. Sewage Combination Air Valve shall be rated for 150 psi working pressure.
4. Sewage Combination Air Valve shall have a 2-inch diameter NPT inlet, 2-inch NPT vent outlet, and ¼-inch venting orifice, unless otherwise recommended by the manufacturer.
5. Valve shall be complete with an isolation valve (between the Combination Air Valve and the process line) and a throttling device installed on the outlet

to allow control of the air discharge rate and pressure and column ascent rate. Valve shall be designed for closure without water hammer or damage to the system.

6. Sewage Combination Air Valve shall be provided with a complete set of manufacturer-furnished and attached backwash accessories to allow periodic flushing of sediment, grease, and solids from the valve. This shall include minimum ½-inch diameter flush inlet and outlet with shut-off valves and quick disconnect couplings, and minimum of 5 feet of back flushing hose with quick disconnect couplings.
7. Valve shall be as manufactured by Crispin Valve (US Series), GA Industries Inc. (Figure 942-F-I), Val-Matic, or approved equal.

2.3 BACK PRESSURE VALVES

A. PVC Piping

1. Back pressure valves shall be sealed spring cage type with TFE diaphragm. Valves shall be capable of reducing line pressure 15 to 50 psi, field adjustable; factory set to 25 psi unless otherwise indicated.
2. Valve body shall be constructed of PVC Type 1, Grade 1, per ASTM D1784.
3. Valve shall be as manufactured by Hayward or approved equal.

2.4 BALL VALVES

A. General

1. Ball valves shall have full pipe area ports unless otherwise indicated.
2. Ball valves shall be of the quarter-turn shut-off type.

B. Metal Piping, 2-1/2 Inches and Larger

1. Ball valves shall have split, carbon steel body with stainless steel trim.
2. Ball valves shall be capable of sealing in either flow direction. Port position shall be positively identified by an external indicator.
3. Ball valves shall have a free floating, self-adjusting, self-cleaning spherical ball with recessed, reinforced Teflon seats.
4. Ball valves shall be KTM Omni I/ Series E0100, Jamesbury Type 6150/9150, or approved equal.

C. Metal Piping, 2 Inches and Smaller

1. Ball valves shall be of brass construction with blowout-proof stem.
2. Ball valves shall be Crane Series F9102, or approved equal.

D. Stainless Steel Piping

1. Type: Standard ball valve with circular port, and top entry to ball.
 - a. Construction:
 - 1) Body: 316 Stainless Steel
 - 2) Ball: 316 Stainless Steel
 - 3) Stem: 316 Stainless Steel
 - 4) Seat: Reinforced TFE
 - 5) Seals: TFE
 - 6) Ends: Threaded or Flanged, Class 150 as shown or specified.
 - 7) Actuator: Manual handlever with gearing, unless an electric motor actuator is shown or specified.
 - b. Manufacturer:
 - 1) ITT Engineered Valves
 - 2) McCanna
 - 3) Or approved equal.

E. PVC Piping

1. Ball valves shall be true union type constructed of Type 1, Grade 1 PVC per ASTM D1784.
2. Provide valves with Viton O-rings and Teflon seats.
3. Valves shall be as manufactured by Hayward, or approved equal.

2.4 CHECK VALVES

A. Metal Piping, 2-1/2 Inches and Smaller

1. Check valves shall be the horizontal, single disc, swing type, unless otherwise indicated. Valves shall have removable disc, bronzed discs or disc rings and bronze disc hinges and pins and shall be designed to give a full diameter passage.
2. Valve bodies shall be bronze except the 2-1/2 inch size which shall be cast iron.
3. Pins, discs and other parts shall be properly adjusted to operate satisfactorily. An arrow indicating flow direction shall be provided.

B. PVC Piping, 2-1/2 Inches and Smaller

1. Check valves shall be of the true union ball check type with socket welded fittings, unless otherwise indicated.

2. Valves shall be constructed of PVC Type 1, Grade 1, per ASTM D1784, with EPDM uniseat and Viton "O" rings.
3. Valves shall be as manufactured by Hayward or approved equal.

C. PVC Piping, 3 Inches and Larger

1. Valves shall be swing type with bolted cover, equipped with outside lever and weight.
2. Valves shall be constructed of PVC Type 1, Grade 1, per ASTM D1784.
3. Valves shall be as manufactured by Hayward or approved equal.

D. Stainless Steel Piping

1. Check valves shall be the horizontal, single disc, swing type, unless otherwise indicated. Valves shall have retained gasket and integral seat. Valve shall be designed to give a full diameter passage.
2. Valve bodies shall be stainless steel with flanged ends. Gasket and seal shall be Teflon.
3. Pins, discs and other parts shall be properly adjusted to operate satisfactorily. An arrow indicating flow direction shall be provided.
4. Valves shall be Crane/Aloyco Figure 377, Velan Figure 0114C-13SX, Tyco Rovalve S157 or approved equal.

2.5 DIAPHRAGM VALVES

A. PVC Piping

1. Valves shall be constructed of PVC Type 1, Grade 1, per ASTM D1784.
2. Provide diaphragm valves with grade P1 (TFE) diaphragms.
3. Valves shall be as manufactured by Hayward or approved equal.

2.6 DRAIN PLUGS

- A. Drain plug shall be capable of sealing the drain with the drain cover in place.
- B. Drain plug shall be constructed of polyurethane or approved equal.

2.7 ELECTRIC VALVE ACTUATORS

- A. Electric actuators shall be provided for valves where indicated, and shall meet the requirements of the Section entitled "Electrically-Operated Primary Control Valves".

- B. The valve manufacturer shall be responsible for furnishing the valve actuators. The valve actuator shall be coordinated with and shall be compatible for operation with each valve supplied. The valve manufacturer shall be responsible for coordinating the specific requirements of the valve actuators with the electric actuator manufacturer.

2.8 FLAP VALVES

- A. Flap valves shall have a cast iron body and flap gate, with bronze hinge pin. Valve seats shall be bronze or Neoprene.
- B. Flap valves shall be as manufactured by Rodney Hunt, M&H, or approved equal.

2.9 [NOT USED]

2.10 GATE VALVES

- A. Metal Piping, 2-1/2 Inches and Smaller
 - 1. Gate valves shall be the single disc, double seat, tapered wedge type, unless otherwise indicated.
 - 2. Valves shall be built to the manufacturer's standards with materials and construction conforming to the requirements of MSS SP-80.
 - 3. Valve bodies shall be bronze, except the 2-1/2 inch size which shall be cast iron.
 - 4. Valves shall be as manufactured by Crane Valves or approved equal.

2.11 GLOBE AND ANGLE VALVES

- A. Globe and angle valves 1/8-inch through three inches shall meet the requirements of MSS SP-80.
- B. Globe and angle valves shall have Teflon impregnated packing.
- C. Valves shall be as manufactured by Nibco, Crane, Walworth or approved equal.
- D. Hose Bibbs
 - 1. Hose Bibb Valves
 - a. Hose bibb valves for interior and exterior service shall be bronze angle type valve, with N.P.T. threaded connections, pressure rated for 125 psi.
 - b. Hose bibb valve shall have screw-in bonnet, integral seat, renewable TFE disc, and rising stem threaded operator with aluminum handwheel.

- c. Hose bibb valve size shall be 1 ½-inch unless otherwise indicated with adapter for standard garden hose. Configuration shall be as indicated in the Contract Drawings. Exterior, wall-mounted hose bibbs shall be frost proof and provided with exterior faceplate, siphon breaker and interior isolation valve.
- d. Hose bibb valves shall be as manufactured by Nibco, Inc., Model T-311, or approved equal.

2. Hose Rack

- a. Provide each hose bibb with a stainless steel or nickel-plated steel wall-mount hose rack sufficient to support a 50-foot length of 1 ½-inch diameter hose, with adapter for standard garden hose.
- b. Mount hose rack within 4-foot vicinity of hose bibb unless otherwise directed or indicated.
- c. Hose rack shall be as manufactured by Integra Companies, Inc. (Bedford, MA), model HSU-100AS, or approved equal.

E. Needle Valves

Needle valves shall be of globe or angle type, brass construction. Valves for water service shall be Crane No. 85, 88 or 89; Walworth Nos. 120 or 124; or approved equal. Valves for air service shall be Crane No. 57, Walworth No. 58, or approved equal.

2.12 PLASTIC GLOBE VALVES FOR CHEMICAL SERVICE

A. PVC Piping, 2 inches and Smaller

- 1. Valves shall be constructed of PP conforming to ASTM D4101 Cell Classification PP0210B67272.
- 2. Valve seals shall be constructed of EDPM or FKM.
- 3. Valves shall be of union bonnet design.
- 4. The materials of construction shall be compatible with the chemical service for each application. The contractor shall submit all materials of construction and chemical compatibility charts for all valves and valve accessories to be used for chemical service.
- 5. Valves shall be as manufactured by Asahi/America or approved equal.

2.13 MUD VALVES

- A. Mud valves shall be of the heavy duty flanged type designed to provide a positive seal under both seating and unseating head conditions. The valve shall be non-rising stem style.

- B. The frame, yoke and gate shall be sturdily proportioned for strength and rigidity and be of cast Type 316 stainless steel. After machining, all castings shall be passivated in accordance with ASTM A-380. Valves which include components welded from stainless steel are not acceptable.
- C. Mechanically retained seat shall be field-replaceable. Seats and seating washers shall be SBR or Buna-N rubber.
- D. Provide 2" operating nut, extension stem, stem guides, and fasteners. All materials shall be Type 316 stainless steel. The stem shall be guaranteed against stem galling for the life of the plant or coated against galling. The valve stem shall have Acme threads with the minimum diameters as shown below:

Valve Size	Minimum Stem Diameter
4", 6"	1-1/4"
8", 10", 12", 16"	1-1/2"
18", 20"	1-3/4"

- E. Floor Box Valve Operator
- a. Provide where shown or specified.
- b. Provide a sealed floor box with lid for each valve. Floor Boxes shall be constructed of Class 30 cast iron. They shall include a bronze bushing with an inside diameter 1/16" larger than the outside diameter of the extension stem and shall be retained with two stainless steel screws. The overall height of the floor box shall be 6". The underside of the casting shall have 2-1/2" female threads to accept a pipe nipple, to extend the length for thicker floor slabs. Floor boxes shall be provided with a bolt-down lid and O-Ring, to seal the floor box from the top side.
- c. Provide a heavy-duty, non-corrosive position indicator and debris shield in each floor box. The position indicator shall be of the planetary gear design. The sun gear, planet gear and ring gears will be constructed of non-corrosive Delrin. All Delrin components shall be white in color, to enhance visibility. The scale plate will be clear polycarbonate. Housings of carbon steel or aluminum will not be accepted. Fasteners shall be stainless steel. The top scale plate shall have markings representing the number of turns, contain the word "Closed", and a directional arrow. The markings shall be permanently recessed, embossed or engraved in the scale plate. The use of adhesive labels is not acceptable. The "open" line shall be marked on a transparent polycarbonate window, which will be field adjusted to the exact number of turns of each valve. After calibration, the position of the adjustable "open" window shall be secured to the top surface of the scale plate by the outside diameter of three stainless button head cap screws.
- d. Provide one T-handle.

- F. Provide floor stand operators for all other valves or where operator type not otherwise specified. Floor stands shall be Type 316 cast stainless steel indicating type with sealed indicator slot, and stainless steel mounting hardware. The word "OPEN" shall be cast in the pedestal at the top of the indicating slot. A "CLOSED" tag shall be field mounted to the pedestal to indicate the closed position of the valve. Fabricated welded floorstands are not acceptable. The coupling used to connect the floorstand stem to the extension stem shall be Type 316 stainless steel.
- G. Bolt pattern for mud valves shall match the mating flange. Provide nuts, bolts, and gaskets for mounting to floor pipe flange. Fasteners shall be Type 316 stainless steel, ASTM A193, Grade B.
- H. Mud valves shall be as manufactured by Trumbull Industries Inc., Troy Valve, or approved equal.

2.14 PETCOCKS AND GAUGE COCKS

A. Petcocks

Petcocks shall be lever operated, of brass construction, Crane No. 702 or approved equal.

B. Gauge Cocks

Gauge cocks shall be of brass construction. Gauge cocks shall be Crane Catalog Nos. 708, 712 or 744, or approved equal, as required.

2.15 PRESSURE REDUCING VALVES

A. General

- 1. Pressure reducing valve shall maintain a constant downstream pressure regardless of changing flow rate and/or inlet pressure.

B. Metal Piping, 2-1/2 Inches and Smaller

- 1. Pressure reducing valves shall be sealed spring cage type. Valves shall be capable of reducing line pressure 25 to 75 psi, field adjustable; factory set to 50 psi unless otherwise indicated.
- 2. Provide pressure reducing valve with an upstream wye strainer.
- 3. Valve bodies shall be bronze, except the 2-1/2 inch size which shall be cast iron.
- 4. Valves shall be Watts Regulator Series LF223 or approved equal unless otherwise indicated.
- 5. Refer to the Section entitled "Metal Piping, 3" and Larger (Plant Water System Service)" for requirements for the Scum Fluidizing Spray pressure reducing valve.

C. Metal Piping, 3" and Larger (Plant Water System Service)

1. Pressure reducing valves shall be designed to maintain a constant downstream pressure regardless of inlet pressure or flow fluctuations. It will include a normally open CRD pressure reducing pilot control that modulates varying the pressure on the main valve cover to throttle the higher inlet pressure to a steady lower downstream pressure as specified in the schedule below.

Service	Downstream Pressure Setpoint
IFAS Foam Spray System	6 psi
Scum Fluidizing Spray	12 psi

2. The valves shall be supplied with a 100-01 full ported unit and shall consist of three different parts; the body with seat installed, the cover with cover bearing and the disc and diaphragm assembly. The diaphragm assembly will be the only moving part. It will be ductile iron and have stainless steel trim internals. Anti-cavitation trims shall be provided for the IFAS Foam Spray and Scum Fluidizing Spray System valves. Pressure changes through the remaining valves shall be evaluated for potential damages from cavitations, and anticavitation trims shall be provided where necessary.
3. The main will have an NSF 61 fusion bonded epoxy coating on all internal and external ferrous metal surfaces. The cover of the main valve will have a locating lip for ease of maintenance and to maintain alignment of the stem within the disc/diaphragm assembly. The main valve cover fasteners will be stainless steel. The cover will be one piece. There shall be no pins in the cover for alignment. The main valve will be of the packless design and shall have no orings or packing anywhere within the main valve. The main valve will have stainless steel cover bolts and nuts. The main valve will have 150ansi flanged ends rated to 250psi.
 - a. The Scum Fluidizing Spray main valve shall have 300A threaded ends.
4. The pilot control system will consist of a normally open CRD pressure reducing pilot. The pilot control system will also contain an "Y" strainer to prevent any debris from entering the control loop. The main valve cover will have an X101 visual valve position indicator for monitoring the valve position at any time. There shall also be gauges mounted in inlet and outlet. The pilot, tubing and fittings shall be stainless steel.
5. Valves shall be manufactured by Cla-Val Co., or approved equal.

2.16 PRESSURE RELIEF VALVES / BACKPRESSURE VALVES

- A. Relief valves shall be spring loaded and field adjustable, angle pattern unless otherwise indicated.

B. PVC Piping

1. Valves shall be constructed of PVC Type 1, Grade 1, per ASTM D1784. Provide Viton diaphragm and seals.
2. Valves shall be as manufactured by Hayward or approved equal.

C. Metal Piping

1. Valves shall be constructed of carbon steel with stainless steel nozzle and disc.
2. Valves shall be as manufactured by Crosby Valve and Gauge Company (Style JOS), or approved equal.

2.17 PULSATION ACCUMULATORS/DAMPENERS

- A. Provide pulsation accumulators/dampeners designed for chemical service on the suction and/or discharge piping of diaphragm type positive displacement metering pumps where indicated in the Contract Drawings.
- B. Pulsation accumulators/dampeners shall absorb instantaneous pressure changes due to flow changes in piping systems connected to positive displacement pumps. Dampeners for pump suction piping service (accumulators) shall be suitably sized for a maximum flow fluctuation of ± 5 percent based on mean discharge pressure. Dampeners for pump discharge piping service shall be suitably sized for a maximum flow variation of ± 10 percent based on mean discharge pressure.
- C. Pulsation accumulators/dampeners shall be of the type that separates the process fluid from a rechargeable air chamber with a molded elastomer diaphragm. Other wetted parts shall be Type 316 stainless steel or inert plastic material to prevent corrosion by the process fluid. Provide materials suitable for the intended service.
- D. Provide air chamber side of accumulator/dampener with tire valve type of charging valve and air pressure gauge with shutoff valve. Provide liquid side with an isolation valve and drain valve.
- E. Pulsation accumulators/dampeners shall be rated for 150 psi at 100 degrees F.
- F. Pulsation accumulators/dampeners shall be as manufactured by Pulsafeeder or approved equal.

2.18 QUICK CONNECTORS

- A. Quick couplings, adapters, and caps shall conform to A-A-59326 (MIL-C-27-487) and shall be Kamlock Quick Couplers as manufactured by Civacon/OPW Division of Dover Corporation, or approved equal.
- B. Construction material shall be polypropylene.
- C. Quick connectors shall have viton gaskets/seat.

- D. Sizes, locations and arrangement shall be as shown on the Contract Drawings.
- E. Connectors shall be of the following types:
 - 1. Connectors attached to chemical lines - female x male NPT (OPW 633-B)
 - 2. Valve end - male x male NPT
 - 3. Nozzle end - female x male NPT

2.19 SIGHT FLOW INDICATORS

- A. PVC Piping
 - 1. Sight flow indicator shall consist of a flapper or rotor in order to visually detect flow.
 - 2. Flow indicator shall be constructed of PVC Type 1, Grade 1, per ASTM D1784.
 - 3. Sight flow indicator shall be rated to at least 75 psi.
 - 4. Sight flow indicator shall be manufactured by Ernest Gage Co. or approved equal.

2.20 SOLENOID VALVES

- A. Solenoid valves shall be electrically energized, normally closed valves. Contractor shall coordinate provision of normally open type solenoid valves where required for proper function of equipment or system. Solenoid valves for seal water systems shall be normally open valves.
- B. Solenoid valves shall be sized in accordance with the pressure conditions in the pipeline in which the valves are installed.
- C. The body and bonnet shall be of forged brass and the solenoid core shall be of stainless steel, unless otherwise indicated.
- D. The coils shall be designed for 115-volt, 60-hertz operation and shall be embedded in molded plastic. Provide enclosures in accordance with NEMA Type 4 or NEMA Type 7 unless otherwise indicated.
- E. Shutoff, two-way type solenoid valves shall be Automatic Switch Company (ASCO) Series 8210. Three-way type solenoid valves shall be ASCO Series 8300 or approved equal.
- F. Each solenoid valve shall be preceded by a strainer supplied by the solenoid valve manufacturer. The strainer shall have a bronze body with a stainless steel element, ASCO Series 8600 or approved equal.
- G. Contractor shall provide an isolation valve both upstream and downstream and a bypass valve for each solenoid valve to allow solenoid valve to be taken out of

service.. Isolation and bypass valves and bypass piping shall be provided for all solenoid valves, regardless of whether it is shown on the Contract Drawings. Bypass line size shall match the solenoid valve size.

2.21 STRAINERS

A. Wye Strainers

1. Wye type strainers shall be equipped with blow-off ports and removable plugs for sediment removal.
2. Metal Piping
 - a. Wye strainers shall have cast steel bodies and shall be furnished with 40 mesh stainless steel screen with reinforced ends, unless otherwise indicated.
 - b. Wye strainers shall be as manufactured by Crane Valves, GA Industries Inc., Metraflex Company, or approved equal.
3. PVC Piping
 - a. Wye strainers shall have PVC bodies and Viton seals. Strainers shall be furnished with PVC screens perforated with 1/16-inch holes.
 - b. Wye strainers shall be Chemtrol series "CYS" or approved equal.

B. Basket Strainers

1. General

Basket strainers shall have a flow-through path, with removable metal strainer elements. Strainers shall be provided with threaded drain ports and plugs.
2. Metal Piping, 2-1/2 Inches and Smaller

Basket strainer, unless otherwise shown or indicated, shall be Muessco No. 146, with bronze body and brass basket with 1/16-inch perforations, or approved equal.
2. Metal Piping, 3 Inches and Larger
 - a. Duplex Basket Strainers
 1. Duplex strainers shall consist of two parallel strainers designed to continuously remove particles from the process flow. Duplex strainer shall be configured to be able to switch from one basket to another, for basket isolation and cleaning, without need for shut down of the line.

2. Duplex strainers shall have cast-iron bodies with ANSI flanged connections. Baskets shall be perforated stainless steel, with openings in accordance with recommendations of the manufacturer of the equipment served by the strainer, and in no case larger than ½-inch. Duplex strainers shall have quick-opening covers to facilitate clean out.
3. Duplex basket strainers shall be as manufactured by EATON, or approved equal.

2.22 TELESCOPING VALVES

- A. Telescoping valve shall be sized to fit riser pipe and penetrate the riser pipe a minimum of 9-inches in the up position, unless otherwise shown on Contract Drawings. Coordinate telescoping valve installation in piping free of obstructions to ensure sufficient vertical clearance for full range of operation.
- B. Telescoping valve shall be of the rising, rack-and-pinion type with gearbox, and handcrank operator assembly, unless otherwise shown on Contract Drawings. Operator assemblies shall be provided with grease fittings to facilitate lubrication. Telescoping valve shall have visible level indication, with weather-resistant clear cover and level markings in ½-inch increments.
- C. Telescoping valve materials shall be corrosion-resistant, with stainless steel wetted parts. Slip tube shall be constructed of Type 304 stainless steel, with a 150-lb. stainless steel companion flange. All hardware shall be stainless steel. Provide dielectric insulation between flanges of dissimilar metals.
- D. Telescoping valve shall be gasketed with an adjustable, split wiper gasket designed for prevention of leakage through the interface. Wiper gasket shall be neoprene. Gasket shall be replaceable with slip tube and gearbox assembly in place.
- E. Telescoping valve unit shall be provided with Type 304 stainless steel wall bracket and floor stand mounted to a 1/2-inch thick stainless steel base plate. Gusset plates of 1/4-inch stainless steel shall be provided for added strength.
- F. Telescoping valves shall be provided with an aluminum scum baffle.
- G. Telescoping valves shall be Watt by Latanick, or approved equal.

2.23 SOLENOID-OPERATED CONTROL VALVES

- A. Operation
 1. The solenoid-operated control valve shall be designed to de-energize open to provide a back up potable water feed. During normal operations, the valve will be energized and remain closed.

2. The solenoid valve shall include a pilot control system with independent opening and closing speed controls. Installed in the main valve cover shall be an X105L2W dual limit switch assembly. It shall provide a dry contact output valve position status for remote monitoring.

B. Construction

1. The main valve shall be ductile iron and have stainless steel trim. The flanges shall be 150 ANSI rated to 250 psi. The main valve shall have an NSF approved fusion bonded epoxy coating on all ferrous metal surfaces.
2. The control solenoid on the valve shall be stainless steel along with all stainless steel tubing and fittings.
3. The cover studs and nuts shall be stainless steel.
4. The control valve solenoid shall have a manual operator feature so it can be opened and closed without power being present.

C. The valve manufacturer shall provide a direct factory employee for start up and adjustment at no cost to the customer.

D. The valve manufacturer shall warranty the valve for 3 years from date of shipment.

E. The solenoid-operated control valve shall be manufactured by Cla-Val Co. or approved equal.

2.24 VALVE ACCESSORIES

A. Extension Stem Guides

1. Stem guides shall be installed as wall brackets to support extension stems.
2. Stem guides shall be constructed of high strength cast iron, with a bronze bushing. Maximum unsupported stem length shall be seven feet, unless otherwise specified to be shorter.
3. Stem guides shall be as manufactured by or recommended by the manufacturer of the valve served.

B. Floor Boxes

1. Floor boxes shall be mounted flush with the top surface of the slab and provided with a length equal to the thickness of the slab.
2. Floor boxes shall provide support for extension stems and provide a cover for the operating nut on the extension stem. The floor box shall be the bushing type provided with bronze bushings to preserve stem alignment.
3. Floor boxes shall be as manufactured by or recommended by the manufacturer of the valve served.

C. Valve Boxes

1. Valve boxes shall be as shown in the Contract Drawings.
2. Valve boxes shall be as manufactured by or recommended by the manufacturer of the valve served.

2.25 FOAM CONTROL NOZZLES

A. Provide weighted swing arm-type foam control nozzles for the IFAS foam control and scum fluidizing spray systems.

B. Operation

1. The IFAS foam control nozzle design shall include a counterweight lever that provides a flat spray pattern at low pressure (3 psi), when the counterweight is down and the nozzle is in the 'spraying position'. The counterweight lever of the nozzle shall be designed such that when the orifice clogs, the lever can be lifted to 'flushing position' to allow water to flow straight through the orifice and flush out any clogging solids from the nozzle.
2. The scum fluidizing spray nozzle design shall include a counterweight lever that provides a flat spray pattern at low pressure (10 psi), when the counterweight is down and the nozzle is in the 'spraying position'. The counterweight lever of the nozzle shall be designed such that when the orifice clogs, the lever can be lifted to 'flushing position' to allow water to flow straight through the orifice and flush out any clogging solids from the nozzle.

C. Construction

1. The foam control nozzles shall be of brass construction, with an elastomeric SBR seat and a 1/4" NPT male connection.
2. Split- eyelet connectors shall be used to connect the foam control nozzles to the Utility Water source piping.

D. Foam control nozzles shall be placed in the IFAS tanks and scum wells as shown on the Contract Drawings.

E. The foam control nozzles shall be manufactured by Spraying Systems Co. or approved equal.

2.26 WALL-TYPE HYDROSTATIC PRESSURE RELIEF VALVE (GROUNDWATER RELIEF

- A. The wall type hydrostatic pressure relief valve shall be suitable for side wall installation in tanks. The valve shall be of the 10 degree offset seat design with offset single pivoted hinge. The flap gate and body shall be of cast iron conforming

to ASTM specifications A-126 B. The body seat ring and hinge pin shall be furnished of bronze. The gate shall have a neoprene rubber seat cemented and mechanically retained in place by a retainer plate. The body seat ring shall be threaded and screwed into place and the face machined to a smooth finish.

- B. The valve shall be a 4" flanged end faced and drilled to ANSI 125 pound template for connection to a 4" wall pipe.
- C. Wall pipe for mounting of the pressure relief valve shall be a 4" ductile iron special PEXFL tapped for studs provided with an integral grate and integral wall/thrust collar.
- D. On the exterior of the tank over the PE wall pipe opening, provide and install a ¾"x 3/4" Type 304 stainless steel mesh min. 12" all around opening. Provide 1 CU YD AASHTO No. 57 coarse aggregate around opening.
- E. Provide stainless steel bolts for mounting the pressure relief valve to the wall pipe.
- F. Mounting height for the relief valve shall be approximately 1 ft above tank floor to centerline of valve. Match mounting height of existing pressure relief valve.
- G. Wall type pressure relief valves shall be furnished by Clow Valve Company, M&H Valve, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The installation of all valves shall be in accordance with the Contract Documents and manufacturer's recommendations.
- B. Charge air chambers of pulsation accumulator/dampeners to manufacturer's recommended charging pressure.

3.2 FIELD PAINTING

- A. The field painting of all valves shall be in accordance with the painting specified for the pipeline into which the valve is installed.
- B. Valves painted with asphalt varnish shall be coated with a minimum of one coat of Inertol "tar stop" or approved equal or sand-blasted as specified in the Section entitled "Painting" before additional coats are applied.

3.3 FIELD TESTING

- A. Check valves for correct direction of flow, rated pressure and required body stampings.
- B. After installation, the Contractor shall operate all valves to demonstrate operation without binding or strain. Operate all valves once through open/close cycle. Motor operated valves shall be operated twice. Valves shall operate freely.

C. Any deficiencies shall be corrected at the Contractor's expense.

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SECTION 40 05 29

HANGERS AND SUPPORTS FOR PROCESS PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing hangers and supports complete with all accessories as indicated in accordance with the Contract Documents for process mechanical equipment.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society of Mechanical Engineers (ASME)
 - a. B31.1, Pressure Piping
 - 3. American Society for Testing and Materials (ASTM)
 - 4. American Standards Association, Inc. (ASA)
 - 5. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - a. SP-58, Pipe Hangers and Supports – Materials, Design and Manufacture
 - b. SP-69, Pipe Hangers and Supports – Selection and Application
 - c. SP-90, Guidelines on Terminology for Pipe Hangers and Supports

1.4 SYSTEM DESCRIPTION

- A. General
 - 1. Pipe hangers and supports include all metallic hanging and supporting devices and all concrete piers for above-ground or interior pipeline conduits and fittings, except electrical conduits.

2. Hangers and supports for electrical work are specified in the Section entitled "Conduits".

1.5 SUBMITTALS

- A. Provide submittals in accordance with the General and Supplementary Provision requirements, including the following items:
 1. Catalog data for supports, fasteners, inserts and anchors.
 2. Shop drawings for the following:
 - a. Piping layout drawings with pipe support locations and type noted.
 - b. Pipe support calculations.
 - c. Details of intermediate structural steel members required to span main structural steel for support of piping, equipment, and ductwork.
 - d. Details of methods for attachment of hangers and supports to building construction for equipment and piping 4 inches and larger.
 - e. Details of guide and anchor installations.
 - f. Details of trapeze hangers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. All equipment furnished under this Section shall be furnished by manufacturers who meet the quality, workmanship, and experience requirements as specified in the Division 01 Section of this contract.
- B. The following manufacturers are named to establish a standard of quality necessary for the Project:
 1. Anvil International, Inc. (formerly Grinnell Company)
 2. Or approved equal

2.2 GENERAL

- A. Hangers and supports shall be adequate to maintain the supported load in proper position under all operating conditions.
- B. Factor of Safety
 1. Hangers and supporting devices shall be designed to provide a minimum working safety factor of 3.5.

2. The safety factor for pipe hangers and supports shall be based on supporting pipe filled with water.
- C. Hangers and Supports for Hazardous Chemical Piping (seismic design)
 1. Refer to the structural drawings for project structural and seismic design criteria.

2.3 MATERIALS AND CONSTRUCTION

- A. Hangers and Supports for Corrosive Areas
 1. Hangers, supports, and struts located in corrosive areas shall be Type 304 stainless steel with stainless steel hardware. All areas are considered to be corrosive.
 2. Supports for low pressure air piping shall be as specified in the section entitled "Stainless Steel Process Piping (Air, Low Pressure) and as detailed in the General Mechanical Details for fixed and sliding pipe supports.
 3. Refer to "Hangers and Supports for non-corrosive Indoor Areas" below for general requirements.
- B. Hangers and Supports for non-corrosive Outdoor Areas
 1. Unless specified as stainless steel elsewhere, hangers, supports, and strut located outdoors shall be stainless steel after fabrication in accordance with ASTM A123. All hanger hardware shall be stainless steel. Zinc plated hardware is not acceptable for outdoor use.
 2. Refer to "Hangers and Supports for non-corrosive Indoor Areas" below for general requirements.
- C. Hangers and Supports for non-corrosive Indoor Areas
 1. Pipe

Pipe for supports shall be stainless steel in accordance with the following standards:

 - a. Wrought Steel Pipe - ASTM Des: A 53 Schedule 40
 - b. Cast Iron Pipe - ASA Des: 21.6 and 21.8, Thickness Class 22
 2. Pipe and Castings

Structural steel, wrought metals and metal castings used for hangers and supports shall meet the requirements of the applicable Sections.
 3. Hangers

- a. Overhead hangers for pipes eight inches in diameter and smaller shall be supported by stainless steel threaded rods and shall be Split Ring Type.
- b. Overhead hangers for pipes 10 inches in diameter and larger, and for smaller pipes where shown or specified, shall be single rolls and sockets.
- c. Ceiling flanges shall be utilized for pipes 8 inches or less. Concrete rod attachment plates shall be utilized for pipes larger than 8 inches.

4. Supports

- a. Brackets for supporting piping from walls or columns shall be furnished with back plates where required to prevent the safe bearing capacity of the wall from being exceeded.
- b. Saddle stands shall be of the adjustable type, with floor flanges for bolting to floors or foundations.
- c. Where piping is installed on structural steel supports, blocking or pipe rolls shall be provided to prevent lateral pipe movement.
- d. Insulated pipes 2-1/2 inches in diameter and larger shall be provided with protection saddles as requested or specified.
- e. Beam and channel clamps shall be of stainless steel.
- f. Channel sections shall be complete with clamping nuts and fittings. Channel sections systems for piping supports systems shall be Series PS-200 Power Strut or approved equal. Finish for channel sections and fittings shall be stainless steel conforming to ASTM A153. All exposed channel ends shall be provided with end caps.
- g. Concrete pier supports shall be of Class "B" (4000 psi) concrete. 60 durometer rubber shall be placed between concrete and pipe.
- h. Pipe sections continuously supported by channel iron shall be as follows:

For PVC Pipe:

<u>Pipe Size (inches)</u>	<u>Maximum Hanger Spacing (feet)</u>	<u>Size of stainless steel (inches)</u>
2"	10	2
3"	10	3
4"	10	4

- i. Clamps for supporting piping (3/8" to 4") from walls shall be stainless steel.

5. Inserts

- a. Inserts for concrete shall be hot dipped galvanized and shall be installed in concrete structures where required and where shown on Contract Drawings.
- b. Continuous inserts shall be PS-349 by Power Strut or approved equal.
- c. Spot inserts shall be Power Strut G-152 or approved equal.
- d. All concrete inserts shall have plastic coated filler to prevent concrete seepage.

6. Hanger Rods

- a. Hanger rods for installation in wet areas shall be continuously threaded, Type 316 stainless steel. Hanger rods for installation in other areas shall be continuously threaded, hot dip galvanized steel unless otherwise indicated.
- b. The minimum acceptable size hanger rod for each installation shall be determined from the following table:

<u>Size of Pipe-Inches</u>	<u>Diameter of Rod-Inches</u>
Up to 2	3/8
2-1/2 to 3-1/2	1/2
4 and 5	5/8
6 and 8	3/4
10 and 12	7/8
14 and 16	1
18 to 30	1-1/4
36 to 42	1-1/2
42 to 48	1-3/4

- c. Hanger rods shall be provided with two removable nuts each end, of like material (Type 316 stainless steel or hot dip galvanized as required), for positioning and locking rod in place.

7. Anchor Bolts

- a. Provide stainless steel anchor bolts, nuts and washers, type 316, meeting requirements of the Section entitled "Metal Fabrications" and as indicated on the Drawings. Unless otherwise indicated, size anchor bolts to the largest diameter that will pass through the bolt holes of the equipment base. Length of the bolts shall be long enough to permit a minimum of one inch of grout beneath the base plate and a minimum of three inches anchorage into the structural concrete.
- b. Provide anchor bolts, nuts and washers together with template or setting drawing sufficiently in advance to permit anchor bolts to be set

either prior to or during structural concrete placement.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation shall be performed as recommended by the manufacturer and shall be such that the centerline elevations of supported piping are maintained in an orderly manner.

B. Pipe Hangers and Supports

1. Horizontal metal pipe shall be supported in accordance with the following schedule:

<u>Pipe Size</u>	<u>Maximum Hanger Spacing</u>
1/2 to 1-1/4 inch	6'-0"
1-1/2 to 2 inch	10'-0"
2-1/2 to 3 inch	10'-0"
4 to 6 inch	15'-0"
over 6 inch	17'-0"

2. Horizontal plastic pipe shall be supported in accordance with the following schedule:

<u>Pipe Size</u>	<u>Maximum Hanger Spacing</u>
1/2 to 1-1/4 inch	4'-0"
1-1/2 to 2 inch	5'-0"
2-1/2 to 3 inch	6'-0"
over 4 inch	6'-6"

1. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
2. Install a hanger within 12 inches of each horizontal elbow.
3. Use hangers with 1-1/2 inch minimum vertical adjustment.
4. Support horizontal cast iron pipe adjacent to each hub, with five feet maximum spacing between hangers.
5. Support vertical piping at every floor.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Support riser piping independently of connected horizontal piping.
8. Unless otherwise shown, specified or directed, no piping shall be supported from other piping, or from stairs, ladders or walkways.

9. Hangers and supports shall be installed such that piping live and dead loads and stresses from movement do not transmit to connected equipment.

C. Inserts

1. Concrete inserts shall have plastic coated filler to prevent concrete seepage.
2. Inserts shall be provided for suspending hanger rods and hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Where concrete slabs form finished ceiling inserts shall be provided flush with slab surface.

D. Where pipe is insulated, provide insulation shields and high-density insulation inserts.

E. Upper Hanger Attachments

1. Upper hanger attachments shall be made to structural steel wherever possible.
2. Power driven pins shall not be used.
3. Expansion nails shall not be used.
4. Powder driven fasteners shall not be used in pre-cast concrete.
5. Loads in excess of 250 pounds shall not be supported from a single welded or powder-driven stud.

F. Steel Frame Construction

1. Provide intermediate structural steel members where required by ductwork support spacing.
2. Secure upper hanger attachments to steel bar joists at panel points.
3. Holes shall not be drilled in structural steel members.
4. Friction clamps shall not be used.

3.2 PAINTING

- A. With the exception of those parts and components customarily furnished unpainted, all metal surfaces shall be shop prepared and coated with rust-inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified. Machined surfaces shall be protected against damage and corrosion by other means.
- B. Perform field painting in accordance with the Section entitled "Painting".

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SECTION 40 05 40.14

WALL CASTINGS AND SLEEVES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for installation of wall castings or sleeves for piping which penetrates a foundation, wall or slab unless noted otherwise on the Contract Drawings.
- B. This Section excludes electrical penetrations; see Section entitled "Conduits".

1.3 DEFINITIONS

- A. Wall casting shall mean a casting or fabricated special into which a pipeline terminates when passing through a foundation, wall or slab.
- B. Sleeve shall mean a casting or fabricated special inserted in the foundation, wall or slab through which a pipeline passes.

1.4 SUBMITTALS

- A. Layout drawings showing location and size of each foundation, wall or slab penetration.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Wall castings shall be cast or ductile iron and shall be of the configuration as shown on the Contract Drawings.
- B. Sleeves shall be solid cast or ductile iron castings or fabricated from Schedule 40 steel pipe.
- C. Wall castings and sleeves shall be provided with waterstops when installed in poured concrete foundations, walls, slabs, and elsewhere as shown.
 - 1. Waterstops for fabricated sleeves shall be at least the same thickness as the sleeve and a minimum of 2 inches in width.
 - a. Attach by continuous fillet weld both sides around the sleeve.

- (1) MIG weld shall be used on cast or ductile iron.
2. Waterstops for castings shall be the manufacturer's standard.

PART 3 INSTALLATION

3.1 GENERAL

- A. Wall castings and sleeves shall be installed at the location and elevations as shown on layout drawings or Contract Drawings.
 1. Location shall be verified with the installer of the carrier pipe before concrete is poured.
 2. Support wall castings and pipe sleeves embedded in concrete walls, floors, and slabs with formwork to prevent contact with the reinforcing steel.
- B. Castings and sleeves installed in walls and ceilings shall be flush with the finish surface, unless otherwise indicated.
- C. Where wall pipes or sleeves are to be installed flush with the wall or slab, the flange or bell shall be tapped for studs. Where the flange or bell will project beyond the wall, the projection shall be sufficient to allow for installation of connecting bolts.
- D. Sleeves in floors shall be fabricated from Schedule 40 steel pipe.
 1. In areas not requiring escutcheons or plates, the sleeve shall extend 4 inches above finished floor.
- E. Coat wall castings and pipe sleeves as appropriate for the environment where the casting or sleeve is located in accordance with the Section entitled "Painting".
- F. Sleeves installed shall be sealed with a sealant. The annular space between pipes and sleeves in exterior walls shall be watertight.
- G. Wall pipe and wall sleeves shall be installed when the wall or slab is constructed. Blocking out or breaking of the wall for later insertion shall not be permitted – except where noted on the drawings or required for preloading (Anaerobic / Anoxic Tanks – refer to geotechnical report).

3.2 SIZE

- A. Wall castings shall be the size of the carrier pipe.
- B. Sleeves for modular link type wall seals shall be sized in accordance with the manufacturer's recommendations.
- C. Sleeves for caulking shall be a minimum of one size larger than the carrier pipe.

3.3 SEALANTS

A. Acceptable Sealants

1. Modular link type wall seals as manufactured by Thunderline Corp. or approved equal.
2. RTV foam by Dow Corning (Fire Rated).
3. One or two component synthetic rubber (silicone, polysulfide or polyurethane) base.
4. Lead wool.

B. Sealants shall be installed in accordance with the manufacturer's recommendations.

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SECTION 40 05 40.20

FLEXIBLE PIPE COUPLINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing flexible pipe couplings as indicated in accordance with the Contract Documents.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - a. B16.1 – Cast Iron Pipe Fittings and Flanged Fittings, Class 25, 125, 250 and 800
 - b. B16.5 – Pipe Flanges and Flanged Fittings
 - 2. American Society for Testing and Materials (ASTM)
 - a. D395 – Test Methods for Rubber Properties – Compression Set

1.4 SUBMITTALS

- A. Provide submittals in accordance with the General And Supplementary Conditions, including the following items:
 - 1. Drawings and manufacturer's data showing details of materials and construction.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Contractor shall store and protect equipment specified herein in accordance with the requirements of Division 01.
- B. Materials and equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Such boxes, crates or protection shall be clearly labeled with manufacturer's name, brand or model designation, type or grade and color.

- C. Protect materials and equipment from exposure to the elements and keep dry at all times. Handle and store to prevent damage in accordance with manufacturer's recommendations.
- D. Material and equipment damaged by handling and storage shall be repaired or replaced by the Contractor as directed by the Engineer.

PART 2 PRODUCTS

2.1 GENERAL

- A. Flexible couplings or expansion joints shall be provided for piping systems and at connections to equipment where shown.
- B. The Contractor may install additional pipe anchors and flexible couplings to facilitate piping installation, provided that he submits complete details describing location, pipe supports, and hydraulic thrust protection.
- C. Flexible pipe couplings shall be designed to withstand the test pressure specified for the pipeline in which they are to be installed.
- D. Coupling joints shall be as required to conform to the type of pipe joints at the point of installation, unless otherwise indicated.

2.2 FLANGED ADAPTERS

- A. Flanged adapters shall be assembled units of the wedge-gasketed, flared-sleeve type. Each adapter shall consist of a flanged body with a follower, wedge gasket, flange gasket and sufficient number of steel ~~stainless steel~~ bolts to compress the wedge gasket.
- B. The flange body shall be cast iron with one end properly formed to receive wedge gasket. The flange end of the adapter shall be in accordance with ANSI B16.1, Class 125 lb. cast iron flanges and/or B16.5, Class 150 lb. steel flanges, and shall be equipped with a modified "O" ring gasket.
- C. The follower shall be fabricated of cast iron.
- D. Wedge gaskets shall be made to the following specifications:

Durometer	75 $\pm$ 5
Compression Set	4% Maximum 30 minutes 3% Maximum 3 Hours

Compression set shall be determined upon 3/4" diameter x 1/2" thick discs cut from 3" diameter plaques and subjected to 600 psi for 48 hours at room temperature. In other respects, the procedure shall conform to the requirements of ASTM D395 Method A, using the external loading device. Gaskets shall be of a type of rubber.

- E. The bolts shall be stainless steel elliptical-neck, track-head design with rolled threads. The elliptical-neck shall correspond to the elliptical hole in the flange body to prevent bolt from turning.
- F. Flanged adapters shall be as manufactured by Dresser Industries, Smith-Blair, Inc., or approved equal.

2.3 SOLID SLEEVE TYPE COUPLINGS

- A. Solids sleeve type couplings shall be designed to fit the outside diameter of the pipes they connect.
- B. Sleeves for use in the ground shall be cast construction or epoxy coated steel.
- C. Sleeves for use exposed or submerged shall be stainless steel.
- D. Gaskets shall be natural or synthetic rubber of a grade suitable for the intended service.
- E. Unless otherwise specified or shown the middle ring shall be furnished without a pipe stop and shall have the following minimum dimensions:

<u>Pipe Diameter</u>	<u>Thickness</u>	<u>Length</u>
Less than 6 inch	--	5 inches
6 inch	1/4 inch	5 inches
8 inch - 14 inch	5/16 inch	7 inches
16 inch - 24 inch	3/8 inch	7 inches
30 inch and larger	1/2 inch	10 inches

- G. Bolts and nuts shall stainless steel for non-submerged service and shall be stainless steel for submerged service.
- H. Solids sleeve type couplings shall be as manufactured by Dresser Industries, Smith-Blair, Inc., or approved equal.

2.4 RUBBER EXPANSION COUPLINGS

- A. General
 - 1. Rubber expansion couplings shall be standard spool type.
 - 2. The tube shall be of a single piece construction and extend to the outside edges of the flanges.
 - 3. The flexible pipe coupling shall have ANSI 125-pound flanges.
 - 4. The exterior surface shall be oil resistant.
 - 5. The split retainer rings shall be stainless steel.
- B. Low Pressure Process Air Piping Service

1. Rubber expansion couplings for all low pressure process air piping shall be of the double bellow type, unless otherwise noted.
 2. Axial compression capacity shall be minimum 1.75 inches, and axial extension capacity shall be minimum 1.80 inches.
 3. All low pressure process air piping rubber expansion couplings shall be capable of withstanding a pressure of 15 psig at a temperature of 250°F.
- C. Sewage Piping Service
1. Rubber expansion couplings for all sewage piping shall be of the single bellow type with stainless steel control rods, unless otherwise noted.
 2. Axial compression capacity shall be minimum 0.80 inches, and axial extension capacity shall be minimum 0.40 inches.
- D. Rubber expansion couplings shall be as manufactured by General Rubber Corp., Mercer Rubber Co., or approved equal.

2.5 FLEXIBLE METAL HOSE COUPLINGS

- A. Flexible metal hose couplings in pressure piping to compressors, engines and similar applications shall be seamless corrugated tubing covered with high tensile wire braid.
- B. Couplings shall be bronze unless otherwise indicated.
- C. Flexible metal hose couplings for engine exhaust and other non-pressure piping shall be strip wound galvanized steel unless otherwise indicated.

2.6 EXPANSION COUPLINGS

- A. Expansion couplings shall be the internally guided sleeve type.
- B. Packing shall be suitable for the intended service.

2.7 HARNESS RODS

- A. Stainless steel thrust harness rods shall be provided for flexible couplings on all pressurized piping.
- B. Provide tie rods and harness ears per manufacturer's recommendations for the pressure and service of the pipeline to be installed on.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Prior to installation of couplings, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are

wiped clean before they are installed. If necessary, flexible couplings and gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation of the pipe ends.

- B. Install in accordance with the manufacturer's recommendations.
- C. Bolts and harness rods shall be tightened gradually and equally in stages to prevent uneven alignment and to allow uniform distribution of stress under pressure. Tightening shall be performed by workmen using torque-limiting wrenches.
- D. Couplings shall not be used to support the weight of adjoining pipe or fittings.
- E. When installed for underground or underwater service the coupling and associated harness rods shall be painted, after being installed, with two coats of tar pitch preservative coating unless otherwise shown.

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SECTION 40 05 40.30

PRESSURE GAUGES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes direct reading, Bourdon tube pressure gauges for liquid (including wastewater), compressed air or gas service, as shown on the Contract Documents or as specified, complete with accessories.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards, and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society of Mechanical Engineers (ASME)
 - a. ASME B40.1, Gauges – Pressure Indicating Dial Type Elastic Element

1.4 SUBMITTALS

- A. Provide submittals in accordance with the General Conditions and Division 01, including the following items:
 - 1. Shop drawings, including manufacturer's details and materials of construction in compliance with this Specification.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The following manufacturers are named to establish a standard of quality necessary for the Project:
 - 1. Wika
 - 2. Ashcroft
 - 3. Or approved equal

2.2 GENERAL

- A. Gauges shall conform to ASME B40.1.

- B. Gauge range shall be approximately twice operating pressure, unless otherwise scheduled or specified.
- C. Gauges shall be furnished with shutoff cocks, diaphragm seals and pulsation dampeners, unless otherwise specified.
- D. Gauges of like type shall be the product of one manufacturer.
- E. Gauges shall be 4 ½-inch unless otherwise shown. Minimum gauge size shall be 2 ½-inch diameter.
- F. Provide 4 ½-inch pressure gauges with graduations as scheduled below (expressed in pounds per square inch gauge pressure).

<u>Maximum</u> <u>Indications</u>	<u>Figure</u> <u>Intervals</u>	<u>Intermediate</u> <u>Graduations</u>	<u>Minor</u> <u>Graduations</u>
15	1	0.5	0.1
30	5	1	0.2
60	5	1	0.5
100	10	5	1
160	20	5	1
200	20	10	2
300	30	10	2

- G. High Temperature Applications

Gauge service shall be considered a high temperature application where the upper limit of the process fluid temperature range may be between 150 to 250°F in an ambient temperature of 110°F. Gauges for high temperature applications shall be fabricated and fitted with materials suited for intended application. Contractor shall coordinate suitability of gauge materials for high temperature application with manufacturer. Shop drawings shall include clear indication of suitability of gauge materials for high temperature application.

2.3 MATERIALS

- A. Bourdon-Tube Gauges

- 1. Cases

- a. Cases shall be solid-front, blowout-back safety type, fabricated of stainless steel. Finish shall be black except for stainless steel.
- b. Dial covers shall be heavy plastic, acrylic or polycarbonate, unless otherwise specified.
- c. Gauges to be wall or flush mounted shall be provided with flanged case suitable for mounting configuration.
- d. Provide glycerin or silicone filled case.

2. Bourdon Tubes
 - a. Bronze unless otherwise specified.
3. Accuracy
 - a. Pressure gauges shall be rated for a minimum accuracy of ± 0.5 percent of full span (ASME B40.1 Grade 2A), unless otherwise specified.
 - b. Vacuum and combination gauges shall be rated for a minimum accuracy of $\pm 2\frac{1}{2}$ percent of span (ASME B40.1 Grade A), unless otherwise specified.
 - c. Gauges for high temperature applications shall be rated for a minimum accuracy of $\pm 3\frac{2}{3}$ percent of span (ASME B40.1 Grade B).
4. Movements
 - a. Movements shall be brass or stainless steel.
 - b. Movements shall be adjustable for recalibration.
- B. Shutoff Cocks
 1. Shutoff cocks shall be provided for each gauge whether shown or not on the Contract Drawings.
 2. Shutoff cocks shall be constructed of Type 316 stainless steel.
- C. Pulsation Dampeners
 1. Stainless steel construction.
 2. Adjustable by pin size or pin location.
- D. Diaphragm Seals
 1. Stainless steel housing.
 2. Type 316 stainless steel diaphragm.
 3. Liquid filled gauges shall be factory assembled.
- E. Isolation Rings
 1. Isolation rings shall be provided for pressure gauges and switches on all sludge lines (primary, WAS, RAS, and RFP feed).
 2. Isolation rings shall be Ashcroft Type 80 or approved equal
 3. Assembly flange material shall be 316 stainless steel (when installed in metal

piping) or CPVC (when installed in plastic piping).

4. Inner Flexible Wall shall be Buna N unless otherwise specified.
5. Fill fluid shall be glycerin or silicone unless otherwise specified.

PART 3 EXECUTION

3.1 GENERAL

- A. Gauges 4 ½-inch or larger, where not panel or wall mounted, shall be supported by suitable brackets.
- B. Provide dielectric insulation where connection is made between corrosion causing dissimilar metals.
- C. Gauges shall be protected until acceptance.

3.2 FIELD TESTING

- A. Test each gauge for proper function prior to or during testing of system served.
- B. Malfunctioning gauges shall be replaced prior to conclusion of system testing, at no additional cost to the Owner.

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SECTION 40 05 53

IDENTIFICATION FOR PROCESS PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing nameplates, labeling and identification methods for mechanical equipment and components.
- B. Contractor shall label all process piping systems, equipment, and valves as specified in Divisions 33, 35, 40, 41, 43, and 46.

1.3 SUBMITTALS

- A. Submit Shop Drawings in accordance with Division 01 requirements for the following:
 - 1. Shop drawings for valve service identification charts. Charts shall be developed by the Contractor and shall contain the following information:
 - a. Valve tag number.
 - b. Valve location.
 - c. Valve size and service.
 - d. Valve manufacturer's name and model number.
 - 2. Catalog data for nameplates, pipe markers, tags, and accessories, including letter size and color, background color, label size, and method of application.
 - 3. A schedule of each item to be provided identifying by name and tag number (if applicable) the specific equipment, valve, pipe, or duct requiring identification.
- C. Submit samples for nameplates, pipe markers, and tags, including samples of symbols and abbreviations, letter size, color for coding, and a complete list of legend wording, in accordance with Division 01 requirements.

PART 2 PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

A. Equipment Identification Nameplates

Nameplates shall be two-color laminated plastic not less than 1/16 inch thick, machined engraved to show black letters on a white background.

B. Pipe Identification Markers

1. Identifying labels and markings for piping shall conform to ANSI A13.1 for legend, color, visibility, and size of legend and letters.
2. Snap-on Type shall be precoiled acrylic plastic marker with clear polyester coating, incorporating flow arrows, and legend printed in alternate directions.
 - a. For piping or insulation under 6 inch outside diameter (O.D.), label shall be of the one piece wrap around type with $\frac{3}{4}$ inch adhesive strip on inside edge and 360 degree visibility.
 - b. For piping or insulation or insulation 6 inch (O.D.) and larger, label shall be of the strip type with factory applied grommets, secured with stainless steel spring fasteners.
3. Stick-on Type shall be one piece pressure sensitive adhesive backed plastic marker with clear polyester coating, incorporating flow arrows, and legend printed in alternate directions.
 - a. For piping or insulation under 8 inch (O.D.), label shall be of the wrap around type with 360 degree visibility.
 - b. For piping or insulation 8 inch (O.D.) and larger, label shall be of the strip type.
4. Pipe identification markers shall be as manufactured by:
 - a. Seton Name Plate Company, New Haven, CT
 - b. W.H. Brady Co., Milwaukee, WI
 - c. or approved equal

C. Valve Identification

1. Tag type shall be brass, 19 B&S gage, with 1/4 inch high valve service abbreviated lettering over 2 inch high lettering indicating valve tag numbers as shown in the Contract Documents. Lettering shall be deep stamped and black filled. Tags shall have 3/16 inch diameter hole(s) at top for fastening.

2. Tag size shall be 1-1/2 inch diameter round.
3. Tag fasteners shall be brass "S" hook or brass jack chain, size as required for valve stem or handle to which tag is attached.
4. Provide two framed valve charts for each process piping system to have valve identification tags.
5. Valve service identification chart frames shall be satin finished extruded aluminum frame of size to fit 8-1/2 x 11 inch valve chart and complete with rigid clear plastic glazing.
6. For all chemical system valves, tags and fasteners shall be corrosion resistant material.

D. Duct Identification Letters and Numbers

1. Type shall be of the stick-on type, made of all purpose polyester, single character letters and numbers.
2. Color shall be black letters on bright yellow background.
3. Size of Lettering:
 - a. 12 inch or less duct or insulation dimension (or diameter) to which the lettering is applied: 1 inch high lettering.
 - b. Greater than 12 inch duct or insulation dimension (or diameter) to which the lettering is applied: 3 inch high lettering.

PART 3 EXECUTION

3.1 EQUIPMENT IDENTIFICATION

A. General

1. Identify mechanical equipment, bare or insulated by use of nameplate.
2. Provide new identification for existing equipment where existing nameplate differ from nomenclature used in the Contract Documents.
3. Size of Lettering
 - a. Use the largest lettering size (3 inch or 1 inch height) that will easily fit the available surface space.
 - b. Use only one lettering height on any given piece of equipment. Do not mix lettering sizes.

B. Location and Content of Identification

1. Equipment shall be identified with a minimum of two sets of lettering. Center identification lettering, vertically and horizontally, on opposite vertical sides of the equipment.
2. Vertical sides selected shall have the longest dimension. Label sides of equipment and not the ends, unless view is obstructed to those sides. If view is obstructed to sides of equipment, locate identification lettering on the two most visible vertical sides and/or ends.
3. Equipment identification numbers and letters shall be as indicated in the individual equipment specifications and shall be formatted similar to the following example:

"AERATION BLOWER
BL-504"

4. Heating, ventilating and air conditioning equipment and control device nameplate nomenclature shall match the control devices, equipment, and components identified on the Contract Drawing schematics and equipment schedules.

C. Installation

Prepare surface to which nameplate is to be applied and install nameplate using adhesive or nylon tie as indicated in each specification.

3.2 VALVE IDENTIFICATION

A. General

1. Valves shall receive identification designated by distinguishing numbers and/or letters.
2. Where applicable, valve designation shall match the designation indicated in the Contract Documents.

B. Installation

1. Fasten tags to valve stems or handles using brass "S" hooks, jack chain or chemical resistant fastener (where applicable).
2. Fasten tags in a manner and location that will permit easy reading, but will not interfere with the operation of the valve.

C. Valve Service Identification Chart

Charts shall be provided, but not installed, for each room where valves are located, and shall list the valves located in the specific room by system name.

3.3 DUCT IDENTIFICATION

A. General

1. Ductwork shall be identified as to type of air being conveyed and, where specified, the air handling, supply or exhaust fan unit to which it is connected by use of stick-on letters and numbers.
2. Identify bare or insulated interior and exterior ductwork with the type of air flow (supply, return, exhaust) and provide air flow directional arrows.

B. Location and Content of Identification

1. Locate identification at ductwork connections to equipment and at ductwork wall penetrations.
2. In addition, at wall penetrations, include the equipment identification number to which or from which the penetrating duct is connected. For example:

"EXHAUST AIR or "SUPPLY AIR
TO EF-2A1" FROM AHU-2A"

3. Horizontal ductwork shall have lettering on opposite sides, along centerline of the duct at each point of identification. Where view of vertical sides is obstructed, apply lettering to be visible from bottom and/or top of duct.
4. Vertical ductwork shall have lettering applied on the two most visible sides, oriented to read from the bottom up-ward, along the centerline of the duct.

C. Installation

1. Prepare surface to which lettering is applied and install lettering in accordance with the manufacturer's instructions.
2. Apply lettering in a straight line along the axis of the duct. Lettering edges should touch, but not overlap.

3.4 MISCELLANEOUS LABELING

- A. "Caution: Low Clearance" nameplates shall be provided in normal walkways where equipment, piping, and structures are installed below 7 feet above finished floor.
- B. "Moving Parts" nameplates shall be provided where mechanical equipment with exposed moving parts are located.
- C. "Non-Potable Water: Do Not Drink" nameplates shall be posted at each hose bibb where non-potable (plant) water is supplied.

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SECTION 40 42 00

PROCESS PIPING AND EQUIPMENT INSULATION

PART I GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Provisions Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing insulation and accessories for process mechanical systems as indicated in accordance with the Contract Documents.

1.3 QUALITY ASSURANCE

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American Society of Testing and Materials (ASTM)
 - a. ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 - b. ASTM C449, Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
 - c. ASTM C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 - d. ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation
 - e. ASTM C552, Standard Specification for Cellular Glass Thermal Insulation
 - f. ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
 - g. ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation
 - h. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials
 - i. ASTM E96, Standard Test Methods for Water Vapor Transmission of Materials
 - 2. Midwest Insulation Contractors Association (MICA)
Commercial and Industrial Insulation Standards
 - 3. National Fire Protection Association (NFPA)

NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials

4. Underwriters Laboratories (UL)

UL 723, Standard for Safety for Surface Burning Characteristics of Building Materials

5. American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc./Illuminating Engineering Society of North America (ANSI/ASHRAE/IESNA)

- a. ANSI/ASHRAE/IESNA 90.1, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings
- b. ANSI/ASHRAE/IESNA 100, Energy Conservation in Existing Buildings

B. Qualifications of Manufacturer

- 1. All equipment furnished under this section shall be furnished by manufacturers who at least five (5) years of experience in the design, production, assembly and field service of systems of like type and size.

1.3 EQUIPMENT IDENTIFICATION

Insulation specified herein shall be labeled in accordance with the Section entitled "Identification of Process Piping and Equipment".

1.4 SUBMITTALS

- A. Submittals shall be developed and submitted in accordance with the requirements of the General Conditions and Division 01, and shall include, but not be limited to, the following:
 - 1. Shop drawings and catalog data. Catalog data for each product describing the product and showing its compliance with specifications. Submit Material Safety Data Sheets (OSHA Form 174) for solvents, adhesives, and loose fill insulation material to be used on the project.
 - 2. Samples of insulating materials, jacket materials, and accessories shall be submitted upon Engineer's request.

PART 2 MATERIALS

2.1 GENERAL

A. Material Fire Properties

- 1. Insulation shall have composite fire and smoke hazard ratings as tested under procedure ASTM E84, NFPA 255, and UL 723 not exceeding:

Flame Spread	25
Fuel Contributed	50
Smoke Developed	50

The only exception to the above rates is for PVC fitting covers.

2. Jackets and accessories shall have the ratings listed above. Insulating materials and accessories used shall be of asbestos-free material.
3. Compatibility of Products
 - a. All insulating materials, jacket materials, and accessories used for a given type of insulating system shall be by a single manufacturer.
 - b. Necessary accessory products not available from the insulation manufacturer shall be of a type and brand as recommended by the insulation manufacturer's literature.

2.2 ELASTOMERIC FOAM (EF) INSULATION

- A. Flexible insulation composed of closed cell elastomeric foam, conforming to ASTM C534, Type I. Temperature range of insulation shall be -40 °F to 180 °F. Thermal conductivity (k) shall be 0.27 BTU in / hr ft² °F at 75 °F.
- B. Insulation shall be preformed, closed cell tubular material with inner and outer surface skin; 5', 6', or continuous lengths.
- C. Insulation for fittings and valves shall be miter cut, and fabricated from materials employed for pipe insulation.

2.3 CELLULAR GLASS (CG) INSULATION

- A. Insulation shall conform to the requirements of ASTM C552 specification for cellular glass block and pipe thermal insulation. Insulation shall be jacketed with a bituminous coating for sealing the exterior surface.
- B. Insulation shall be as manufactured by:
 1. Pittsburgh Corning; Foamglass with Pittwrap jacketing
 2. or approved equal

2.4 FLEXIBLE GLASS FIBER (FGF) INSULATION

- A. Low-density insulation composed of organic glass fibers bonded with a thermosetting resin, conforming to ASTM C553 Type I. Outside shall be unfaced or shall have a reinforced aluminum foil (FSK) face. Temperature limits shall be -20 °F to 250 °F. Density of insulation shall be 1.0 pounds-per-cubic-foot (lbs/ft³). Thermal conductivity (k) for 1.0 lb/ft³ density shall be:

0.28 BTU in / hr ft² °F at 75 °F
0.40 BTU in / hr ft² °F at 200 °F

B. FGF insulation shall be as manufactured by:

1. Johns Manville; Series "Microlite"
2. Knauf; Series "Duct Wrap"
3. or approved equal

2.5 RIGID GLASS FIBER (RGF) INSULATION

A. Equipment and Ductwork

1. Rigid board-type insulation shall be composed of organic glass fibers bonded with a thermosetting resin, conforming to ASTM C553 Type III or ASTM C612 Class 1. Outside shall have a reinforced aluminum foil (foil-scrim-kraft, "FSK") face. Temperature limits shall be -20 °F to 450 °F. Density shall be 3.0 pounds per cubic foot (lbs/ft³). Thermal conductivity (k) for 3.0 lb/ft³ density shall be:

0.25 BTU in/hr ft² °F at 75 °F

0.30 BTU in/hr ft² °F at 200 °F

0.40 BTU in/hr ft² °F at 300 °F

2. RGF insulation for equipment and ductwork shall be as manufactured by:

- a. Johns Manville; Series "800 Series Spin-Glas"
- b. Knauf; Series "Insulation Board"
- c. Or approved equal

B. Piping

1. Insulation shall be molded rigid fiberglass with a PVC jacket and shall meet the requirements of ASTM C547.
2. Insulation shall have a maximum thermal conductivity of 0.28 Btu-in/(hr-ft²-°F) at 75°F. Insulation shall be suitable for a minimum service temperature of 0°F and a maximum service temperature of 350°F.
3. Insulation shall have a maximum moisture absorption of 0.2 percent by volume.
4. The insulation shall be provided with a vapor barrier jacket. The vapor barrier jacket shall be a high-density, white kraft bonded to aluminum foil, reinforced with fiber glass yarn. The moisture vapor permeance shall be a maximum of 0.02 perms as measured in accordance with ASTM E96. The vapor barrier jacket shall be secured with self sealing longitudinal laps and butt strips.
5. RGF insulation for piping shall be as manufactured by:
 - a. Johns Manville; "Micro-Lok"
 - b. Owens Corning; ASJ/SSL-II

- c. or approved equal

2.6 WHITE PVC JACKET FOR PIPE INSULATION

- A. White PVC Jacket shall conform be 0.016 inches thick, smooth finish, with moisture barrier.
- B. Jacket for fittings and valves shall be preformed for 45 and 90 degree elbows, tees, valves, and end caps; material, color, and finish to match pipe jacket.

2.7 ACCESSORIES

A. Insulation Bands and Wire

- 1. Stainless steel bands shall be 3/4 inch wide, 0.015 inch thick stainless steel, annealed.
- 2. Banding seals shall be stainless steel, 3/4 inch wide.
- 3. Banding wire shall be copper coated, steel core, 14 gage, annealed.

B. Insulation Anchors

- 1. Anchors shall be perforated 2-inch x 2- inch flat metal plate with 12 gage wire spindle and washers, and self adhesive backing
- 2. Anchors shall be as manufactured by:
 - a. Goodloe E. Moore Gemco
 - b. Rawl
 - c. or approved equal

C. Adhesives

1. Insulation Adhesives

- a. Elastomeric foam adhesive shall be as manufactured by:
 - (1) Armstrong Cork Co. "520"
 - (2) Stabond Corporation
 - (3) or approved equal
- b. Glass fiber adhesive shall have a synthetic rubber base as manufactured by:
 - (1) 3M Scotch-Grip Insulation Adhesive "33"
 - (2) Johns Manville
 - (3) or approved equal

2. Anchor Adhesives

a. Silicone rubber sealant shall be as manufactured by:

- (1) General Electric "RTV 108"
- (2) Dow Corning
- (3) or approved equal

D. Sealing Tape

1. Tape for sealing glass fiber insulation with facing: Vapor barrier type, color matching, of same material as the covering to which applied and shall be as manufactured by:

- a. Compac "ASJ" or "FSK"
- b. 3M
- c. or approved equal

2. Vinyl tape shall be black, 0.01 inch thick, two inches wide and shall be as manufactured by:

- a. Minnesota Mining "Scotchrap 50"
- b. 3M
- c. or approved equal

E. Sealants

1. Sealant for fiberglass insulation shall be silicone rubber as manufactured by:

- a. Dow Corning "732"
- b. General Electric "RTV 108" Childers "CP-30"
- c. or approved equal

2. Fireproof sealant shall be silicone RTV foam as manufactured by:

- a. Dow Corning "3-6548"
- b. General Electric
- c. or approved equal

F. Finishing Cements

1. Insulating finishing cements shall be a hydraulic setting cement with extremely low drying shrinkage and shall be a thermally efficient insulation with no asbestos.

2. Finishing cement shall be as manufactured by:

- a. U.S. Gypsum (E-Z Coat)
- b. Johns Manville
- c. or approved equal

G. Insulating Cement

1. Insulating cement shall conform to ASTM C449.

H. Weather Proofing Mastic

1. Mastic shall be compounds of selected and processed bitumens and mineral fiber. Mastic shall be weather proofed with vapor barrier coating for insulation.
2. Mastic shall be as manufactured by:
 - a. Johns Manville; "Insulkote"
 - b. Owens Corning
 - c. or approved equal

PART 3 EXECUTION

3.1 GENERAL

- A. Insulation shall be installed after all specified system adjustments and tests have been performed and the systems have been accepted.
- B. Surfaces to be insulated shall be free of dust, grease, oil or loose particles. Clean and dry all Work as necessary prior to applying insulation.
- C. Except as otherwise specified herein, install insulation in accordance with the insulation manufacturer's instructions and accepted industry practice as outlined in MICA's "Commercial and Industrial Insulation Standards".
- D. Neither staples nor thumbtack fasteners shall be used as securements for work installed.
- E. On multiple layer installations, stagger the longitudinal and the traverse joints.
- F. When insulating a union, mark the jacket indicating the union location.
- G. Neatly finish insulation at supports, hangers, anchors, protrusions and other interruptions.
- H. For valve insulation, completely insulate valves up to, but not including, the packing nuts (unless otherwise specified on Contract Drawing).
- I. Locate insulation or cover seams in least visible positions.
- J. The integrity of vapor barriers shall be maintained in accordance with the manufacturer's instructions and recommendations.
- K. Insulation and insulation/jacketing systems installed outdoors shall have continuous weatherproof barrier impervious to wind, precipitation, solar radiation, thermal extremes, and humidity extremes.

- L. Install metal jacket on insulation installed within 5'-0" of finished floor to protect insulation.

3.2 ELASTOMERIC FOAM (EF) INSULATION

- A. Slit insulation lengthwise. Coat joints and longitudinal seams with adhesive and install on pipe.
- B. Seams and butt joints shall be fully covered with adhesive to assure a complete seal and maintain insulation efficiency and vapor barrier.
- C. Miter insulation at elbows.
- D. Do not stretch insulation to obtain longer lengths.

3.3 CELLULAR GLASS (CG) INSULATION

- A. Insulation shall be applied to piping with butt joints staggered and tightly butted.
- B. Longitudinal and butt joints shall be left dry. Joints shall be tightly fitted to eliminate voids. Any remaining void shall be eliminated by refitting or replacing sections of insulation.
- C. Each section of insulation shall be held in place by two wraps of fiber reinforced tape.

3.4 FLEXIBLE GLASS FIBER (FGF) INSULATION

- A. Attach anchors with adhesive to bottom of duct and other places where additional support is required to prevent sagging. Anchors shall be provided three inches from joints (maximum) and uniformly spaced between joints on 18-inch centers.
- B. Install anchors on the sides of all duct risers having a dimension of 24 inches and over. Space anchors in accordance with the following schedule:

<u>Duct Dimension</u>	<u>Anchor Minimum Row and Maximum Spacing Requirements</u>
24" to 32"	1 row, centered 16" on centers
33" to 48"	2 rows 16" on centers
49" to 60"	3 rows 16" on centers

- C. Apply insulation adhesive to duct and insulation surfaces. Use 4 inch strips of adhesive on 8 inch centers.

- D. Wrap insulation around duct. Minimize compression at corners. Vapor barrier facing shall be overlapped a minimum of 2 inches at joints. Seal factory lap on insulation jacket with adhesive.
- E. Where lap joints are not possible, butt joints shall be used. Seal butt joints using tape that matches jacket material.
- F. The protruding end of anchor pins shall be cut flush after speed clips have been applied.
- G. Seal tears and anchor penetrations in vapor barrier jacket with jacket sealing tape. Seal around hanger and similar protrusions with silicone rubber sealant.
- H. Stop and seal insulation around access doors and damper operators to allow operation without disturbing wrapping.
- I. Continue insulation through wall, floor, and ceiling openings, except at fire dampers. Pack opening around duct with glass fiber blanket; seal with fire-proof sealant, both sides.

3.5 RIGID GLASS FIBER (RGF) INSULATION

- A. Equipment and Ductwork
 - 1. Attach anchors with adhesive to bottom of equipment/duct and other places where additional support is required to hold insulation in place. Anchors shall be three inches from all corners of the duct (maximum) with intermediate anchors spaced on 16 inch centers (maximum) in all directions.
 - 2. Apply insulation adhesive to equipment/duct and insulation surfaces.
 - 3. Apply insulation to equipment/duct. Butt all edges of insulation and fill all voids with similar insulation.
 - 4. Seal factory jacket lap on insulation continuously with adhesive. Lap circumferential joints with 4 inch wide jacket material and seal laps continuously with jacket adhesive; or seal continuously with sealing tape (minimum 3 inches wide) of same material as jacket.
 - 5. Install metal corner angles, or prefabricated corner angle tape, over the jacketed corners of the insulation.
 - 6. The protruding end of anchor pins shall be cut flush after the speed clips have been applied.
 - 7. Seal tears and anchor penetrations in vapor barrier jacket with jacket sealing tape. Seal around hanger and similar protrusions with silicone rubber sealant. Seal exposed ends of insulation with sealant.

8. Stop and seal insulation around access doors and damper operators to allow operation of doors and actuators without disturbing wrapping.
9. Continue insulation through wall, floor, and ceiling openings (except at fire dampers); maintain the integrity of the vapor barrier system. Pack opening around duct with glass fiber blanket; seal with fireproof sealant, both sides.
10. Place trapeze hangers, fabricated of steel rods and structural steel channels or angles, outside the duct insulation and jacketing. At all points of support replace duct insulation with high density insulation pieces, of thickness equal to the surrounding insulation (a minimum of 4" wide by the bottom dimension of the duct). Continuously jacket duct insulation and filler pieces through all supports of insulated duct.

B. Piping

1. Install insulation in accordance with manufacturer's recommendations.
2. Wrap insulation around pipe. Vapor barrier facing shall be overlapped a minimum of 2 inches at joints. Seal factory lap on insulation jacket with adhesive.
3. Where lap joints are not possible, butt joints shall be used. Seal butt joints using tape that matches jacket material.
4. Continue insulation through wall openings. Pack opening around pipe with glass fiber blanket; seal with fire proof sealant, both sides.

3.6 JACKET SYSTEM INSTALLATION

- A. Except as otherwise specified herein, install pipe, fitting, flange, and valve jackets in accordance with the jacket manufacturer's instructions and accepted industry practice as outlined in MICA's "Commercial and Industrial Insulation Standards".
- B. No penetrating type securements (such as staples, screws, rivets, etc.) shall be used on jackets incorporating a vapor barrier or on jackets covering an insulation system possessing a vapor barrier.
- C. Lap direction: On overlapping type jacket joints and seams, locate longitudinal and circumferential laps as follows:
 1. Exposed Interior Piping: longitudinal seams and securements in least visible location.
 2. Interior Horizontal Piping: longitudinal seams - facing downward.
 3. Interior Vertical Piping: longitudinal seams - facing wall; circumferential seams - shingle style (upper over lower).
 4. Exterior Horizontal Piping: longitudinal seams - facing downward; circumferential seams - facing east or south.

5. Exterior Vertical Piping: longitudinal seams - facing east or south; circumferential seams - shingle style (upper over lower).
- D. Align longitudinal seams.
- E. When jacketing over a union, mark the jacket indicating the union location.
- F. Neatly finish jacketing at supports, protrusions, and interruptions.
- G. Provide ½ inch safety edge on all exposed longitudinal seams.
- H. Longitudinal lap to be a minimum of two inches. Overlap circumferential joints a minimum of two inches.
- I. Install aluminum bands one inch from circumferential joints and on twelve inch centers. Use one strapping seal to hold the band and a second to cover the cut end of the band.
- J. Use aluminum butt straps where jacket cannot be overlapped. Use 3/4 inch stainless steel bands to hold butt straps.
- K. Seams, joints, and openings in the jacket that cannot be sealed by overlapping the aluminum jacket or by using butt straps to be sealed with silicone rubber sealant.
- L. Provide jacket for valves, tees, and elbows through 12 inches with preformed aluminum jackets.
- M. Provide jacket for other fittings or valves with sheet aluminum fabricated as necessary. End caps shall be aluminum jacketed.
- N. Unless otherwise specified, insulation and jacketing at hangers shall be constructed to match the assembly (for the appropriate hanger type) as shown in MICA's "Commercial and Industrial Insulation Standards", section IV. However, materials and methods shall be limited as indicated in this specification.
- O. Install a metal jacket on all piping insulation within 5'-0" of finished floor.

3.7 REPAIRS TO DAMAGED INSULATION AND JACKETING SYSTEMS

- A. Contractor shall repair damages to insulation and jacking systems using materials and methods to match original installation.
- B. Repairs to vapor barrier type jacketing systems shall fully restore the integrity of the vapor barrier.

3.8 LABELING

- A. Insulated systems shall be labeled in accordance with the requirements of the Section entitled "Mechanical Identification".

3.9 SCHEDULE

A. General: Provide insulation on the systems identified in the Schedule below.

Service (temp. range)	Pipe Size	Insulation Type	Insulation Thickness	Jacket Type
Utility (Plant), Potable & Non-Potable Water Piping (all exterior exposed pipe, see note below)	½" – 6"	EF	1"	PVC
Air Piping, ALP/AHP (350°F max.) (all interior and exterior exposed pipe as specified herein; vertically up to 8 ft above grade, walkway, stair, or finished floor; and horizontally within three ft of a walkway/stair handrail)	½" to 36"	RGF	2"	PVC
Chemical Process Piping and Sample piping (all exterior exposed pipe, see note below)	½" - 4"	RGF	1"	PVC
Fuel Piping (all exterior exposed pipe, see note below)	1"	EF	1"	PVC
Process Wastewater (see drawings and note below)	3/8" – 66"	EF	1"	PVC

Note: At transition from above grade to below grade piping, provide insulation/jacket to minimum 36-inches below grade. All piping that is heat traced shall be insulated.

Legend

AL – Aluminum

CG – Cellular Glass

EF - Elastomeric Foam

FGF – Flexible Glass Fiber

RGF – Rigid Glass Fiber

PVC – Polyvinyl Chloride (If installed outdoors, PVC shall be UV stabilized)

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SECTION 40 80 11

PIPE PRESSURE TESTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes pipe pressure tests for building services piping systems as scheduled in Part 3 of this section.
- B. Refer to Division 33 Section entitled "Piping Systems Testing" for yard piping testing.

1.3 SUBMITTALS

- A. In addition to those submittals identified in the General Conditions and Division 01, the following items shall also be submitted:
- B. Test Reports
 - 1. A separate test report shall be submitted for each pressure test performed.
 - 2. Information presented in test reports shall be typewritten, clear, concise, and accurate.
 - 3. Reports shall be signed and dated by the supervisor in charge of performing the test and designated Inspector. Signatures shall certify that all information contained in the report is true and accurate to the best of the signatory's knowledge.
 - 4. Reports shall contain, as a minimum, the following information:
 - a. Type of test performed (e.g., hydrostatic, pneumatic, Freon, etc.)
 - b. Description of system, or portion of system to which testing was performed.
 - c. Date of test.
 - d. Time of pressure start.
 - e. Time of pressure test completion.
 - f. Test fluid used in test (e.g., tap water, dry air, Freon, etc).
 - g. Pressure reading at beginning of test.
 - h. Pressure reading at end of test.
 - i. Location of pressure indicating devices.
 - j. Precise location of leaks detected.
 - k. Summary of leaks detected and suggested corrective action.

- l. Conclusions regarding overall fitness and condition of tested system.
- m. Signatures as described above.
- n. Appendix: Calibration history of instruments used.

1.4 REFERENCES

- A. Perform pressure tests on piping scheduled below in accordance with International Plumbing Code requirements as applicable.

1.5 QUALITY ASSURANCE

- A. Tester's Qualifications
 - 1. Workers and their supervisors performing the Work of this section shall be personally experienced in testing of pipe systems and shall have been regularly employed by a company with three years minimum experience in testing of similar pipe systems.
- B. Inspection
 - 1. Tests shall be performed by the Contractor in the presence of designated Inspector(s). Witness and signoff is required.
 - 2. Inspectors shall, at all times, have access to any place where work is in preparation or in progress and Contractor shall provide sufficient safe and proper facilities for such access and inspection.

1.6 SCHEDULING AND SEQUENCING

- A. Perform test operations on complete piping system or in sections as required and/or directed to progress Work in satisfactory manner and not delay the general construction of the project.
- B. If testing is performed in sections, valve or cap-off sections of piping to be tested, utilizing valves to be installed in permanent piping systems or temporary valves or caps as required to perform tests.
- C. Transmit written notification of proposed date and time of pressure tests to the Owner's Representative at least 5 days in advance of such tests.
- D. Pressure tests shall be performed prior to the installation of piping insulation or coverings.
- E. Pressure tests on underground piping shall be performed when piping has been partially backfilled with joints exposed.
- F. Pressure tests shall be performed prior to initial operation of piping systems.

PART 2 PRODUCT

2.1 TEST MATERIALS

- A. Test Fluid: Where scheduled, test media shall meet the following criteria.
 - 1. NPW/Utility/Plant Water: Plant Effluent
 - 2. Drinking Water: Treated, chlorinated potable water.
 - 3. Air: Filtered, oil-free, dry compressed air supplied at or above indicated test pressure.

2.2 TEST EQUIPMENT

- A. Gauges: Calibrated, dial-type, suitable for use with specified test fluid. Upper limit of gauge pressure range shall be 1.33 times the specified test pressure. Gauge accuracy shall be 1 percent of the indicated reading or better.
- B. Soap Solution: American Gas & Chemical, "Leak-Tec"; or equivalent.
- C. Air Compressor: Unit rated to supply compressed air at or above required test pressure. Unit shall have necessary filters and driers to deliver clean, oil-free, dry compressed air. Unit shall have shut-off valve installed on discharge connection.
- D. Pressure Relief Valve: Suitable for use with compressed air, set to relieve at 10 to 15 percent above designated test pressure.

PART 3 EXECUTION

3.1 GENERAL

- A. Tests shall be conducted at ambient temperature, unless otherwise specified.
- B. Do not use permanent system pressure gauges for pressure testing; remove and plug or isolate such gauges from the system during pressure tests.
- C. Instrumentation in, or attached to, the piping being tested shall be protected during testing by isolation or removal. Return instrumentation to pre-test condition after completion of pressure testing.
- D. Piping connected to specialties or equipment with a lower pressure rating than the specified test pressure shall be disconnected from the equipment (after the isolation valve) and openings plugged during the pressure test. After the completion of pressure testing, the piping shall be reconnected to the equipment.
- E. Expansion joints shall be provided with temporary restraint or blocked off during testing.
- F. Pressurization of piping systems by liquids or gases shall be executed in a slow and prudent manner to maintain safety, avoid over-pressurization, and avoid excessive leakage.

- G. Piping systems designed for gases that are tested with a liquid may require additional temporary support during tests to support the weight of the liquid. Provide extra support as required.
- H. If the piping fails the test requirements, the Contractor shall determine the cause of leakage, make necessary repairs, and retest the piping. This procedure shall be repeated until the piping complies with test requirements. A separate test report shall be submitted for each test to a piping system or section of piping.
- I. No caulking or putty shall be used in the repair of leaks. Back-welding of threaded joints shall not be permitted as a means of repairing leaks.
- J. Test reports shall be filled out and readings recorded as testing proceeds.
- K. Safety glasses and hard hats shall be worn by personnel involved in or witnessing tests conducted at pressure of 20 psig or greater.

3.2 EXAMINATION

- A. Examine equipment and construction in the area of piping to be tested. Note equipment and existing construction that may be damaged by leakage of the test fluid.
- B. Verify that piping system bracing, alignment harnesses, and thrust restraints are in place before pressure is applied. Concrete restraints shall have cured adequately to withstand test pressure.

3.3 PREPARATION

- A. Protect equipment and construction which may be damaged by leakage of test fluid by covering with appropriate material or removing from area.
- B. Verify that piping to be tested is clean and all outlets in the system are closed.
- C. Open non-outlet valves in piping section to be tested. Check valves that can prevent system sections from being filled or pressurized shall have their discs, etc. removed for testing (restore check valves to their pre-test condition after completion of pressure testing).
- D. Evacuate test areas of personnel not involved in the pressure testing.

3.4 HYDROSTATIC PRESSURE TEST

- A. Install pressure gauge to measure system pressure at low point in system.
- B. Connect pressurization pump to system.
- C. Fill the system with test liquid, opening vents to permit complete filling. Close vents.
- D. Using the pump, raise the pressure in the system to the scheduled test pressure. Hold pressure for a minimum of 1 hour.

- E. Reduce and hold the pressure 20 percent below test pressure. Inspect the entire system for visible leaks. Note location of leaks for repair.
- F. If leaks or defects are found, release the pressure, drain the system, and make repairs. Repair the test procedure on the repaired piping.
- G. If the piping shows no visible leakage, raise the pressure in the system to the scheduled test pressure and isolate the system, under pressure, from the pump. the system should be closed with the pressure gauge indicating test pressure within system.
- H. System shall remain pressurized for the duration indicated in the test schedule. After the specified duration, check pressure reading on system gauge. No detectable drop in pressure shall have occurred in the system.
- I. If a drop in pressure occurs, Contractor shall determine cause. Once cause is determined release the pressure, drain the system, repair pipe as necessary, and retest.
- J. Upon compliance with test requirements, drain the system, remove items added or replace those removed for testing.

3.5 PNEUMATIC PRESSURE TEST

- A. UNDER NO CIRCUMSTANCES SHALL PNEUMATIC TESTING BE PERFORMED ON NON-METALLIC PIPE.
- B. Install pressure gauge to measure system pressure.
- C. Connect air supply to piping system.
- D. Open inlet valve and allow pressure to increase slowly to 25 psig or 20 percent of scheduled test pressure, whichever is LESS.
- E. Close inlet valve and monitor system pressure for the duration indicated in the test schedule. Checking for any drop in pressure that would indicate leaks.
- F. If leaks are detected, locate leaks and judge the safety of bringing the system to the full test pressure. If judged unsafe, relieve the pressure on the system, repair leaks, and retest system at low pressure before proceeding.
- G. Increase pressure to the specified test pressure. Close inlet valve and monitor system pressure for duration specified in schedule. After the specified duration, check pressure reading on system gauge. No detectable drop in pressure shall have occurred in the system.
- H. If a drop in pressure occurs, Contractor shall check all joints and other possible sources of leaks with soap solution. Once cause is determined release the pressure, repair pipe as necessary, and retest.
- I. Upon compliance with test requirements, vent and allow system to return to atmospheric pressure. Remove items added or replace those removed for testing.

3.6 GRAVITY TEST

- A. Perform test before fixtures are installed.
- B. Test by filling system with free standing (i.e., open to atmosphere) test fluid. Note level of fluid at free surface at beginning of test.
- C. Test joints under a minimum standing head as scheduled (see Test Pressure in Schedule), except for upper sections of piping. Test upper sections of piping to overflowing.
- D. Allow test fluid to stand in system for duration scheduled. There shall be no noticeable loss of fluid during the specified duration.
- E. If leaks are detected or if drop in fluid level occurs during specified duration, drain the system, repair pipe as necessary, and retest.
- F. Upon compliance with test requirements, drain system, remove items added or replace those removed for testing.

3.7 PIPE TEST SCHEDULE

- A. Perform pressure tests, of type indicated, on piping system(s) indicated using scheduled test fluid and pressure.
- B. Schedule

<u>UTILITY</u>	<u>TEST METHOD</u>	<u>TEST MEDIUM</u>	<u>TEST PRESSURE</u>	<u>TEST DURATION</u>	<u>LEAKAGE</u>
Domestic and Potable Water	Hydrostatic	Water	100 psig	1 Hour	0
Utility Water	Hydrostatic	Water	150 psig	1 Hour	0
Deionized Water	Hydrostatic	Water	75 psig	1 hour	0
Sanitary Drainage & Vent	Gravity	Water	10 ft. of water	3 hours	0
Process Drainage	Gravity	Water	10 ft. of water	3 hours	0
Compressed Air	Per Specification Section	---	---	---	---
Fire Protection	Per Specification Section	---	---	---	---
Sump Pump Discharge	Hydrostatic	Water	100 psi	1 hour	0
Wastewater, Scum	Hydrostatic	Water	50 psi	1 hour	0
Sludge	Hydrostatic	Water	100 psi	1 hour	0
Chemicals	Hydrostatic	Water	100 psi	1 hour	0

*Note – for fully metallic piping systems, pneumatic testing may be performed in lieu of hydrostatic testing where deemed acceptable by the Engineer. The Contractor must submit a request to perform pneumatic testing, with specific locations identified, to the Engineer for approval prior to testing.

* * * * *

SECTION 40 91 00

INSTRUMENTATION GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes general requirements for all instrumentation as shown on the Contract Drawings and specified under this Contract. This Section shall apply to all instrumentation furnished on this project, regardless of whether it is specifically identified in Division 40.
- B. This section includes requirements for shop drawings, the process control system, field instrumentation, and sensing devices for the project as shown, specified, and as scheduled.

1.3 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - 2. Institute of Electrical and Electronics Owner's Representatives (IEEE)
 - 3. International Society of Automation (ISA)
 - 4. American Water Works Association (AWWA)
 - 5. JIC Standard EGP-1 – Joint Industry Council (JIC)
 - 6. National Electric Manufacturers Association (NEMA)
 - 7. National Electrical Code (NEC)
 - 8. National Electrical Testing Association (NETA)
 - 9. National Sanitation Foundation (NSF)
 - 10. Underwriters Laboratories, Inc. (UL)
- B. Related Specification Sections
 - 1. All Electrical Sections
 - 2. All 409XXX Sections
- C. Definitions
 - 1. See also Section "Electrical General" for additional definitions
 - 2. AI: Analog Input
 - 3. AO: Analog Output
 - 4. CV: Control Valve (Open / Close)
 - 5. DI: Discrete Input
 - 6. DO: Discrete Output

7. FCV: Flow Control Valve (modulating position)
8. Instrumentation – Inclusive of process measurement equipment, field instruments, control signals and conveyance, local indications and alarms, local controllers and PLC's, as well as telemetry and SCADA.
9. LAN: Local Area Network
10. L-O-R Local-Off-Remote selector switch
11. NC: Normally Closed
12. NO: Normally Open
13. OIT: Operator Interface Terminal
14. PCS – Process Control System
15. PCS HMI: PCS Workstations and PCS OITs
16. PCS Workstation: PCS computer with operating system, process monitoring and control graphics software, color monitor, keyboard, and mouse.
17. PS: Pump Station
18. SCADA: Supervisory Control And Data Acquisition
19. TCP/IP: Transfer Control Protocol / Internet Protocol
20. WAN: Wide Area Network

1.4 COORDINATION REQUIREMENTS

- A. Verify layout, installation, process connection(s), electrical connection(s), and ranges for both process and electrical interface.
- B. Materials of construction shall be suitable for the intended application and environment.
- C. Specific mounting requirements

1.5 SUBMITTALS

- A. Submit the following in accordance with the General Conditions and Division 1.
 1. Prior to obtaining any material in connection with the instrumentation of the system, detailed shop drawings on the material shall be submitted.
 2. Submittal Format
 - a. 3-hole punched and neatly bound.
 - b. Each page of each submittal shall be numbered. Page numbers shall be listed on the Table of Contents. Content shall be printed on 8½ x 11-inch paper, or 11 x 17 paper (folded). Larger size drawings shall be folded and placed in labeled individual clear plastic pockets.
 - c. Each submittal shall include:
 - 1) A submittal transmittal letter that shall clearly identify the reason for submittal, e.g., for approval, as manufactured, or as-built / record and include Specification Section reference number(s).
 - 2) Submittals shall have a complete Table of Contents with tabs corresponding to the Table of Contents headings.
 - 3) Compliance Statement: with each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed non-conformities. Provide a short description of minor non-conformities and detailed explanation of other non-conformities.

- d. Product Data:
 - 1) "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data. Label each data sheet with the tag ID assigned to the instrument.
 - 2) Submittals for individual pieces of equipment shall include quantity supplied and the instrumentation tag ID's or other identifying information if a tag ID is not applicable.
 - 3) Power requirements and connection information for all components requiring external power.

B. General Instrumentation Submittal Requirements

- 1. Preconstruction Submittals, including proposed substitutions, supplier and manufacturer qualifications and experience, construction scheduling, Project Plan. The Preconstruction Submittals provided under each Section shall be presented as a single bound submittal.
 - a. Product Data, marked to indicate precisely which items are proposed for each instance within this project.
 - b. Shop Drawings, including process instrumentation and control equipment shop drawing submittals, and preliminary Instrument Loop Diagrams.
 - c. Design Data, including design calculations.
 - d. Factory test reports
 - e. Submit copy of factory quality assurance certificate.
- 2. Post-installation Submittals:
 - a. Certificates including: calibration and warranties
 - b. Field Reports including: inspections, acceptance tests, functional tests, and training records
 - c. Record Drawings: Maintain a full size paper set of "black-line" working drawings throughout the project, and shall carefully record in red any instrumentation modifications. Upon Substantial Completion of the work, sign and deliver copies of the marked-up set of prints to the Engineer. The Engineer reserves the right to withhold final payment until "As-Built" drawings are received.
- 3. Closeout Submittals:
 - a. Spare Parts and Special Tools List: 90 days prior to the scheduled Substantial Completion date, submit a complete list of Spare Parts and Special Tools being provided to the Owner under the CSI scope of supply, and request a time and location for delivery of the Spare Parts and Special Tools to the Owner.
 - b. Operation and Maintenance (O&M) Manuals: Prior to acceptance of the finished project, provide copies of Operation and Maintenance Manuals in conformance with the General Conditions and Division 01. O&M Manuals shall be organized according to Specification Section numbers. Each copy shall be bound in a durable, 3-ring hardback binder, with data sheets individually punched and reinforced to prevent tearout. Data sheets shall be grouped, and binder dividers shall be provided to match the Table of Contents. Each Manual shall have an identifying label on the spine and front cover and shall include the following:
 - 1) List of all CSI provided Instrumentation O&M Manuals in the front of each manual.

- 2) Table of Contents for each manual and each binder
- 3) Copies of each of the Preconstruction and Post-Installation approved Submittals

1.6 QUALITY ASSURANCE

- A. In consultation with the equipment and materials Suppliers, the Contractor shall prepare and submit a Compliance Statement as described in "SUBMITTALS" with each submittal requiring approval.
- B. Manufacturers shall have quality accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Owner's Representative.
- C. Certificates:
 1. Equipment, materials, and installation shall conform to NEC requirements and shall be NRTL-listed and labeled. In particular, control panels shall be UL labeled and listed under UL-805A-2001.
 2. Instrumentation shall have: Underwriters Laboratories, Inc. (UL), FM, CE, or CSA approval.
- D. On-site testing prior to startup and acceptance testing shall be performed as specified in other Sections.
- E. Instrumentation equipment shall be installed as recommended by the manufacturers. Furnish the services of competent factory trained representatives of the instrumentation manufacturer to supervise the installation for proper assembly, startup and operate the equipment, and to conduct the field tests.
- F. Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with ISA, ANSI, ASME, ASTM, IEEE, ISA, JIC, NEMA, and other applicable technical standards. The work shall have neat and finished appearance.
- G. Factory Calibration: Instruments shall be factory calibrated whenever possible to minimize field adjustments and insure proper operation.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Temporary storage of instruments shall be in clean dry indoor rooms with a temporary dehumidifier and electric heating to maintain the storeroom between 5 and 40 °C, with humidity less than 90%. Comply with manufacturer's additional written instructions for storing and periodic inspection and testing.
- B. Handle instrumentation materials and equipment in conformance with the manufacturer's written instructions.

1.8 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions.

- B. Provide an on-site parts and labor warranty for a minimum period of one year after Substantial Completion for all instrumentation and control for process equipment. In cases where the manufacturer offers a longer warranty period, the longer warranty period shall apply as described by the manufacturer.
- C. All instruments that are not fully functional at the time of Substantial Completion shall have warranties extended to provide minimum one year coverage after making the instrument operational, unless otherwise approved by the Owner's Representative.

PART 2 - PRODUCTS

2.1 COMMON WORK TO FIELD INSTRUMENTS ON THIS PROJECT

- A. General
 - 1. Instruments providing similar function shall be of the same manufacturer and, as much as possible, the same model/series for purposes of parts interchangeability.
 - 2. Instruments shall be new, of the latest design, original, free from defects, and shall have a new warranty.
 - 3. Unless otherwise specified, each instrument shall be accurate within 1% of full-scale reading over the calibrated range. This accuracy requirement shall apply to each overall system, including any transmitters, re-transmitters, receivers, etc. that are required.
 - 4. Indicating transmitters are designated by the letter "I" in the Tag ID (i.e. LIT, PIT) and shall have an integral digital display for indication of real-time process values in scaled Engineering Units (EU).
- B. Identification
 - 1. Instrumentation equipment, wires and cables shall be marked in the field in accordance with Electrical Specifications.
 - 2. Instrument tags: All instruments shall be permanently labeled/marked with a metallic (non-corrosive) tag containing the "Tag ID" and "Description". A sample tag shall be submitted to the Owner's Representative for review and approval before commencing instrument tagging.
 - 3. Working instrument tags shall also be provided and be laminated vinyl type, minimum 3 inches by 5 inches with preprinted insert and "write on" type laminate for calibration and servicing information. Tag shall include a pre-punched hole for fastening to instrument with a nylon cable tie.
 - a. Tags shall be Panduit No. PST-5 with lamination on front and back, or approved equal.
 - b. Each instrument tag shall include the following information: front and back (printed, laminated)
 - 1) FIT - 5021 (instrument tag number)
 - 2) xxxxxx TRANSMITTER (instrument type)
 - 3) Manufacturer: xxxxx
 - 4) Model No.: xxxxx
 - 5) Serial No. xxxxx
 - 6) Calibrated Range: xxxxxx
 - 7) Power Supply: xxx V AC or xx V DC
 - 8) Installed by: xxxxxx (Company Name)
 - 9) Anytown, Anystate, USA (Company Address)

- 10) Telephone Number (Company Service telephone number)
- 11) FIT - 5021 (instrument tag number)
- 12) xxxxxx TRANSMITTER (instrument type)
- 13) Calibrated Range: xxxx - xxxx GPM
- 14) Output: 4-20 mA
- 15) Alarms Set @ High: xxxxx
- 16) Low: xxxxx
- 17) Recommended Service Interval: xx months
- 18) Last Serviced on: _____ (handwritten)
- 19) Last Serviced by: _____ (handwritten)

C. Electromagnetic Interference

1. Power conversion equipment, including computer power supplies and Uninterruptible Power Supplies (UPS), shall be fitted with EMI (electromagnetic interference), RFI (radio frequency interference), and telephone interference filters to limit interference effects on other equipment in the surrounding area, in accordance with IEEE standards and recommendations applicable to the equipment.
2. Equipment may be powered from electrical sources that may include harmonic distortion, surges, sags, and other electrical noise under normal operating conditions. Equipment furnished under this Contract shall be installed with such accessories, surge protection, power line conditioners, UPS, or other means as may be required for it to function correctly in this noisy electrical environment.
3. Surge Protection: Power and signal wiring of all instruments located outside of buildings and inline instruments (magnetic flow meters) shall be protected with surge arresting devices.

D. Signal Devices

1. Signal isolator/duplicator(s) shall be used for the retransmission of signals to other areas, other locations, other loops, and especially when leaving the building.
2. Signal isolator/duplicator(s) shall be provided as required to ensure adjacent component impedance match where feedback paths may be generated, or to maintain loop integrity during the removal of a loop component.
3. Signal conditioners and converters shall be provided where required to resolve any signal level incompatibilities or provide required functions.
4. In Hazardous (Classified) areas, intrinsic safety barriers (ISB) and conduit with filled seal-offs shall be used for both power and signal wiring - isolating the hazardous area from the safe area electrically.

E. Materials and Construction

1. Materials of construction shall be suitable for the intended application and environment and fully compatible with the process being measured (especially chemicals).
2. Instruments shall have NEMA 4 rated housings, except in Hazardous (Classified) locations where NEMA 7 and/or 9 with UL listing for the hazard classification is required.
3. Instruments located in areas where they may become temporarily submerged in water shall have a NEMA 6P rated housing. Instruments with permanent submergence shall have NEMA 6P rating.

4. Instruments located in unheated environments shall be provided with heating as required to prevent improper operation from freezing.
5. Electrical enclosures shall have degree of protection ratings suitable for the intended application (e.g., watertight, dust-tight, explosion-proof) and environmental conditions. Instrumentation equipment enclosures shall at a minimum have the following ratings and materials of construction:
 - a. Indoor enclosures: NEMA 12 in clean and dry electrical rooms and control rooms. All other areas, except Hazardous (Classified) locations, shall be NEMA 4X stainless steel.
 - b. Outdoor enclosures: NEMA 4X stainless steel or FRP, except Hazardous (Classified) locations.
 - c. Hazardous (Classified) areas: Epoxy powder-coated cast aluminum NEMA 7 and/or 9 with UL listing for the hazard classification.
6. Shop Finishes
 - a. With the exception of those parts and components customarily furnished unpainted, prepare and coat all metal surfaces with rust inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified.
 - b. Protect machined surfaces against damage and corrosion by other means.

F. ACCESSORIES

1. Instruments shall be provided with required probe holders and installation hardware as recommended by the manufacturer for proper operation.
2. Any devices, equipment, interfaces, hand-held devices, cables, connectors, and solutions necessary to configure, modify, analyze, and calibrate a supplied transmitter shall be provided with the transmitter and be turned over to the Owner after successful commissioning.
3. Where recommended by the manufacturer, power converters, reactors, or power supplies shall be provided integral with the instrument.
4. All indicating displays mounted in direct exposure to the elements will be provided with a weather hood to shield the indication from the elements regardless of the manufacture's recommendations or installation requirements.

G. Spare Parts

1. All instruments shall be provided with one (1) year of supplies (i.e charts, pens, ribbons, filaments, sensors, reagents, etc), spare parts (bulbs, fuses, etc), and calibration solutions necessary for continuous and accurate operation.
2. Spare parts shall include all parts normally provided by the manufacturer for systems of similar size, construction, and purpose.
3. All spare parts shall be packaged in separate containers with the part name and number; local representative's: name, address, and telephone number; name of equipment the parts are for and list of parts contained therein clearly marked. These parts shall be included in the base bid.
4. Provide 25% spare fuses of each type supplied with the instrumentation.

2.2 FIELD INSTRUMENTS

A. Analyzer – Ammonium “Ammonia”

1. Provide a digital sensor for insertion directly into the process with separate transmitter device.

2. Sensor will be a single continuous-reading device through an Ion-Selective Electrode with a reference electrode and integral temperature compensation. The sensor shall compensate for the effects of potassium and temperature.
3. The sensor shall be threaded into an immersion tube and directly immersed into the process by a pendulum frame. The analyzer shall be installed in the locations shown on the contract drawings.
4. Sensor body shall be 316 stainless steel. All parts of the sensor shall be corrosion resistant and fully-immersible.
5. Analyzer shall include an LCD display for trouble shooting and display of process measurement.
6. Provide analyzer with a toggle switch and fuse on the input power.
7. Performance Requirements:
 - a. Calibrated Span: 0.2 - 1000 mg/L NH₄-N
 - b. Ambient Temperature: -20 to 45°C.
 - c. Medium Temperature: 0 to 40°C.
 - d. Response Time: ≤ 120 seconds
 - e. Accuracy: ±5 %
8. Functions and Outputs:
 - a. Discrete Output: 2 programmable relay contacts, 5 A at 30 Vdc
 - b. Analog Output: isolated 4-20mA
 - c. Power Supply: 120 VAC, 60 Hz
 - d. Cabinet Protection: NEMA 4X (IP 65)
9. Options/Accessories:
 - a. System shall be provided with an auto cleaning system complete with air compressor.
 - b. The probe shall be suspended within the chamber by a stainless steel chain and shall be of sufficient length to reach either wet well.
 - c. Provide project specific mounting hardware. Hardware shall be stainless steel for use in corrosive environment.
 - d. Mounting shall be provided to facilitate easy sensor relocation between either wet well and cable management as noted on the drawings.
 - e. Probe shall be supplied with sufficient connecting cable for installation as shown and specified.
 - f. Sensor signal wiring and power supply shall be provided with surge protection equipment as specified.
10. Manufacture/Model:
 - a. Hach Company – AISE sc ISE Ammonium Probe with RFID Technology and with SC200 Controller
 - b. Endress + Hauser – CAS40D Ammonia ISE with CM442 transmitter
 - c. Approved equal
11. Schedule:

TAG	DESCRIPTION	SPAN
AE/AIT-270A	Primary Effluent Pump Station Ammonia	0.2-1000 mg/L NH ₄ -N

B. Analyzer – Hazardous Gas

1. System shall continuously analyze the LEL values of combustible gases and provide an alarm when one of the sensors reaches set percentages of the LEL. Accuracy shall be within 5 percent of full scale.
 - a. System shall be rated for operation within the hazardous location and have hot swappable sensors that are rated to be replaced under power within the hazardous classified area.
 - b. System shall provide local display of gas levels and provide integral interface to display diagnostics and faults.
 - c. System shall provide a sensor/s common trouble alarm.
2. Provide local indicating transmitter with local display and 4-20mA output directly proportional to the measured gas levels.
3. Combustibles (Methane) Sensors shall utilize infrared point gas detection for continuous monitoring of combustible gasses and vapors. Accuracy shall be within 5 percent of full scale. Sensors shall be mounted within 2 feet of the highest point within the area. System shall continuously analyze 0-100% Lower Explosive Limit (LEL).
 - a. Provide a “Combustible Gas High” discrete alarm at a threshold level of 20% LEL.
 - b. Provide a “Combustible Gas High - High” discrete alarm at a threshold level of 50% LEL.
4. System shall be:
 - a. Oldham IR (preferred)
 - b. MSA Ultima XIR Gas Detection System
 - c. Approved equal
5. Schedule:

TAG	DESCRIPTION	RATED
AE/AIT-163	Fine Screen Building Gas Monitor local indicating transmitter with Remote Mount Combustibles Sensor	Class 1, Div. 2, Group D
AE/AIT-164	Fine Screen Building Lower Level Gas Monitor local indicating transmitter with Remote Mount Combustibles Sensor	Class 1, Div. 2, Group D

C. Analyzer – Hazardous Gas / Environmental Alarm

1. Enclosure shall be NEMA 4X
2. Alarm horn individually driven
3. Amber strobe light individually driven
4. Remote Strobe & Horn as provided by Cooper Industries, Edwards Signaling & Security Systems, or approved equal.
5. Schedule:

TAG	DESCRIPTION	RATED
YAI-165-1	Fine Screen Building North Gas Monitor Alarm horn and strobe	Unclassified
YAI-165-2	Fine Screen Building South Gas Monitor Alarm horn and strobe	Unclassified
YAI-263-1	Pri. Sludge Pump Station No. 1 North Ventilation Alarm	Unclassified
YAI-265-2	Pri. Sludge Pump Station No. 1 South Ventilation Alarm	Unclassified

YAI-276	Primary Effluent Pump Station Process Alarm	Unclassified
YAI-520-1	Secondary Gallery Entrance	Unclassified
YAI-520-2	Secondary Gallery Entrance	Unclassified
YAI-520-3	Secondary Gallery Entrance	Unclassified
YAI-520-4	Secondary Gallery Entrance	Unclassified

D. Analyzer – Nitrate

1. The system shall consist of a microprocessor-based transmitter, a nitrate concentration sensor and mounting accessories for the transmitter and the sensor.
2. The nitrate concentration sensor should use a multi-beam, pulsed light technique with a Xenon photoflash lamp source to compensate for changes in color, turbidity/suspended solids, and organic material. It should use a dual wavelength with 254 nm for reference and 214 nm for measurement. It should measure the absorption of nitrate at 214 nm.
3. The sensor head should be built of stainless steel, use quartz windows and be rated to NEMA 6P. The body should be made of black polyoxymethylene (POM).
4. Process temperature rating of the sensor shall be no less than 36F to 104F.
5. The nitrate transmitter housing should be a corrosion-free NEMA 4X field housing with a separate cover to access the connection terminals.
6. The system shall have an LED display for measured values and for configuration menu, diagnostics and calibration.
7. The system shall a configurable relay for alarm and cleaning purposes.
8. The system shall have one isolated 4-20 mA analog output
9. The mounting accessories: Mounting hardware should be made of stainless steel, including a stainless steel suspension chain for the immersion probe.
 - a. Primary Effluent Pump Station mounting shall be provided to facilitate easy sensor relocation between two wet wells and cable management as noted on the drawings.
10. Provide a compressed air or wiper instrument automated cleaning system
11. Manufacturer/Model:
 - a. Hach Nitratax Plus sc UV Sensor with SC200
 - b. Endress+Hauser - Model CAS51D with CM442 transmitter
 - c. Approved equal
12. Schedule:

TAG	DESCRIPTION	SPAN
AE/AIT-270B	Primary Effluent Pump Station Nitrate	0.2 – 50 mg/L NO3-N
AE/AIT-340	Bioreactors Effluent Nitrate	0.2 – 50 mg/L NO3-N

E. Analyzer – Orthophosphate

1. Colorimetric measurement.
2. At the beginning of each measurement cycle the analyzer measures the sample for purposes of self compensating the measurement.
3. Performance Requirements
 - a. Measurement range: 0.05 to 15 mg/L
 - b. Accuracy: 2% ±0.05 mg/L
 - c. Reproducibility: 2% ±0.05 mg/L
 - d. Response time: Less than 5 minutes (T90), including sample preparation
 - e. Measurement interval: 5 to 120 minutes, adjustable

- f. Locally provided with diagnostics.
4. Provided with a complete filtration unit and self cleaning system for proper operation within an insitu type installation measuring directly from the basin.
5. Shall accept a single 120Vac, single phase, 60 Hz power
6. Shall provide a 4-20 mA signal directly proportional to the orthophosphate measurement.
7. Shall provide a dry relay contact for indication of a common trouble alarm.
8. Analyzer shall be PHOSPHAX sc Phosphate Analyzer with Filterprobe sc and sc1000 transmitter as manufactured by Hach, Endress + Hauser Stamolys CA71PH, or approved equal.
9. Schedule:

TAG	DESCRIPTION	SPAN
AE/AIT-450	Pre-filtration Orthophosphate	0.00-10.00 mg/L

F. Analyzer - Turbidity/TSS Monitoring

1. The connections between the turbidimeter and interface unit will include plug & play connections.
2. The analyzers shall measure turbidity or suspended solids inserted into an open tank. The probe shall have a self-cleaning system to prevent erroneous values and maintenance problems caused by gas bubbles and sludge particles. Measurements shall be accurate, continuous, and completely independent of color.
3. Include a self-cleaning PVC or stainless steel immersion probe with 33' (10m) cable, microprocessor-controlled interface module and power supply.
4. The analyzers shall operate with a user-selected measurement range of 0.001 to 4000 NTU for turbidity, and 0.001 to 50.0 g/L for suspended solids. An operating temperature of 32 to 104 °F for the probe and -4 to 104 °F for the interface module. Response time shall be less than 1 second and is user-adjustable up to 5 minutes. The accuracy shall be less than 1% of reading or ±0.001 NTU, whichever is greater for turbidity and less than 5% of reading for suspended solids. Repeatability for turbidity shall be less than 1% of reading, and less than 3% for suspended solids reading.
5. Provide 4-20 mA output directly proportional to the turbidity.
6. The turbidimeters shall be Hach Solitax ts-line sc SS Wiper with SC200, Endress + Hauser Turbimax W CUS 41, or approved equal.
7. Schedule:

TAG	DESCRIPTION	SPAN
AE/AIT-308-1	IFAS Zone 1 Suspended Solids	0.001-4000 NTU
AE/AIT-308-2	IFAS Zone 2 Suspended Solids	0.001-4000 NTU
AE/AIT-308-3	IFAS Zone 3 Suspended Solids	0.001-4000 NTU

G. Flow Transmitter – Magnetic – Indicating

1. Flow meters shall mount directly in the pipe.
2. Interface:
 - a. Magnetic meters of less than 12 inches shall be ANSI Class 150 flanged carbon steel flow tubes with PTFE liners.
 - b. Magnetic meters 12 inches or greater in diameter shall have AWWA Class D carbon steel flanges with Hard Rubber liners.
3. Meters shall have electrodes manufactured of Hastelloy C4 or Stainless Steel 316.

4. 316 stainless steel grounding rings shall be installed and properly grounded for all flow meters larger than 2 each.
5. Provide Teflon-type gaskets, deformable under pressure, between measuring tube or grounding rings and pipe flanges.
6. Accuracy of $\pm 0.5\%$ of rate from 1 to 30 ft/s and ± 0.005 ft/s from low-flow cutoff to 1.0 ft/s.
7. The electronics portion of the magnetic flow meter shall be separately mounted, rated NEMA 4X, and include a signal converter. The signal converter shall be wall mounted, or EMR mounted (stand-alone or railing) adjacent to the meter and shall be housed in a stainless steel or polycarbonate case. The converter shall include a separate customer connection section to isolate the electronics compartment and protect the electronics from the environment. A separate terminal strip for power connection shall be supplied. The electronics shall be of the solid state, feedback type and utilize integrated circuitry. Full-scale range of 1-40 ft/s settable in user-definable flow units. The converter shall not be affected by quadrature noise nor shall it require zero adjustment in the field or special tools for start-up. Input and output signals shall be fully isolated.
8. The output signal shall be 4-20 mA directly proportional to the volumetric flow rate.
9. Provide all meters with direct in-line verification. Meter shall verify the integrity of the flow tube and transmitter without removal from the process, any required additional equipment such as field calibrator shall be provided.
10. Flow tube and electronics shall be hydraulically calibrated together at a facility located in the United States and the calibration shall be traceable to the National Bureau of Standards. A computer printout of the actual calibration data giving indicated versus actual flows at a minimum of three (3) flow rates shall be provided with the meter.
11. Flow tubes shall be rated NEMA 6P
12. Electronics shall be potted and/or be suitable for installation in "Hazardous" classified spaces as noted and/or shown on the Drawings.
13. The interconnecting cable of sufficient length shall be supplied with the meter. Contractor shall field verify all installations prior to ordering cables.
14. Manufacturer for bid price (A proposed deduct is requested and will be considered to accept alternative manufacturers – Rosemount, Endress + Hauser, Krohne, or approved equal)
 - a. Meters shall be ABB WaterMaster with VeriMaster.
 - b. Or approved equal

15. Schedule:

TAG	DESCRIPTION (P) = Potted, (H) = Hazardous Area	PIPE SIZE	SPAN	TRANSMITTER MOUNTING
FE/FIT-138	(H) Influent Flow Meter	24"	0-17,000 gpm	EMR-Stand alone
FE/FIT-139	(H) Flow Retention Basin Flow Meter	42"	0-17,000 gpm	EMR-Railing
FE/FIT-162	(H) WAS to Primary Clarifiers at Fine Screen	4"	0-500 gpm	Wall
FE/FIT-265	Primary Sludge Discharge Flow Meter	4"	0-500 gpm	Wall
FE/FIT-280C	PEPS to An-Aerobic Zone 3 Flow Meter	30"	0-11,000 gpm*	EMR-Railing

FE/FIT-280B	PEPS to An-Aerobic Zone 2&3 Flow Meter	30"	0-21,000 gpm*	EMR-Railing
FE/FIT-280A	PEPS Discharge Flow Meter	30"	0-21,000 gpm*	EMR-Railing
FE/FIT-327-1	(P) Biological Reactor No. 1 Effluent Internal Recycle Flow	18"	0-5,000 gpm	EMR-Railing
FE/FIT-327-2	(P) Biological Reactor No. 2 Effluent Internal Recycle Flow	18"	0-5,000 gpm	EMR-Railing
FE/FIT-327-3	(P) Biological Reactor No. 3 Effluent Internal Recycle Flow	18"	0-5,000 gpm	EMR-Railing
FE/FIT-328-1	(P) Biological Reactor No. 1 Internal Recycle Flow	24"	0-10,000 gpm	EMR-Railing
FE/FIT-328-2	(P) Biological Reactor No. 2 Internal Recycle Flow	24"	0- 10,000 gpm	EMR-Railing
FE/FIT-328-3	(P) Biological Reactor No. 3 Internal Recycle Flow	24"	0- 10,000 gpm	EMR-Railing
FE/FIT-519-1	Anaerobic No. 1 RAS Flow Meter	12"	0-7,500 gpm	Wall
FE/FIT-519-2	Anaerobic No. 2 RAS Flow Meter	12"	0-7,500 gpm	Wall
FE/FIT-519-3	Anaerobic No. 3 RAS Flow Meter	12"	0-7,500 gpm	Wall
FE/FIT-531-1	(H) Pre-Thickener No. 1 WAS Flow	4"	0-500 gpm	Integral
FE/FIT-531-2	(H) Pre-Thickener No. 2 WAS Flow	4"	0-500 gpm	Integral
FE/FIT-533-1	(H) Pre-Thickener No. 1 Primary Sludge Flow	4"	0-500 gpm	Integral
FE/FIT-533-2	(H) Pre-Thickener No. 2 Primary Sludge Flow	4"	0-500 gpm	Integral

* Note that the maximum flow of the IFAS system is not to be exceeded.

H. Flow Transmitter – Ultrasonic – Indicating - Open Channel

1. The open channel flow transmitter shall be a non-contact, echo-time measuring type. It shall consist of a transducer and separate transmitter unit connected by manufacturer's specified cable.
2. The transducer shall include an ultrasonic signal generator/ receiver (probe). A reference reflector or alternate method shall be furnished as part of the assembly to provide compensation for variations in temperature, atmospheric pressure, humidity and density. The transducer shall be furnished with a corrosion resistant mounting bracket having leveling screws where required. The transducer shall be suitable for surface or pipe yoke mounting.
3. The transmitter shall be of all solid-state design utilizing high reliability circuit elements and shall be microcomputer controlled. The transmitter shall convert a raw level measurement to flow rate and provide a 4-20 mA signal directly proportional to the flow.
4. The direct reading zero adjustment shall eliminate the need for precise positioning of the transducer. Any calibration instruments required for start-up or field range change shall be furnished with the instrument. The span shall be adjustable from 4 to 72 inches with resolution to 0.01 inches. Accuracy of output

shall be dependent on the span selected and shall be 1.0% of span or better. An internal alarm relay contact shall be field selectable for either 0% or 100% of flow.

5. The unit shall operate on 120 VAC, 50/60 Hz, be provided with local digital display.
6. The transmitter shall be housed in a NEMA 4X corrosion resistant housing, suitable for surface mounting. The transmitter shall be rated for operation in temperatures from -4°F to 120°F (-20°C to 50°C).
7. The transducer shall be hermetically sealed within a housing that is resistant to the corrosive nature of the application. The transducer shall be capable of operating in harsh environments with temperature ranges from -40°F to 176°F (-40°C to 80°C).
8. Then transmitter shall include an integral direct reading totalizer display and shall periodically log historical data.
9. Both the installed transmitter and transducer shall be shielded from direct sunlight.
10. Accuracy to $\pm 1\text{mm/m}$.
11. Manufacturer: Siemens Milltronics (preferred), Endress & Hauser, Pulsar FlowCert, or approved equal.
12. Schedule:

TAG	DESCRIPTION	SPAN	NOTE
FE/FIT -125	Headworks Bypass Flow to River	0-30 MGD	Remote Transmitter

I. Level Switch - Float

1. Mercury-free, mechanical tilt float level switch, with a sealed cable and an impact & corrosion resistant ABS or PVC shell.
2. Float switch cable shall be provided with sensor as an integral assembly. The cord shall be 16 gauge 2 or 3 conductor SJOW oil resistant CPE, of sufficient length to allow connection at junction box (without splices, unless otherwise shown).
3. The contact rating shall be 10 amp at 120 VAC.
4. Install float with weights as necessary for proper operation at the correct level and location.
5. Cables shall be of sufficient length to mount the float switches at the locations shown on the Contract Drawings, plus an additional 10 feet (minimum) of cable. Cables shall be
6. provided in continuous lengths between the float and the associated junction box or control panel. Excess cable shall be coiled and tie-wrapped to the cable mounting supports.
7. Manufacture/Model: Warrick Series M, Flygt ENM-10, Magnetrol T10, Pepperl & Fuchs, or approved equal.
8. Schedule:

TAG	DESCRIPTION	SETPOINT
LSLL-270-1	PEPS Wet Well 1 Low Level Float	EL. 72.05 (8.38 feet)
LSLL-270-2	PEPS Wet Well 2 Low Level Float	EL. 72.05 (8.38 feet)

J. Level Switch – Stem Float

1. Replace in kind
2. Float switch mounted to a mounting stem shall operate Non-mercury type Form C SPST contacts rated not less than 100VA.
3. Floats shall be of either 316 Stainless Steel or Buna N. The stem may be of Stainless Steel.
4. Stem floats shall be Gems Sensors LS-1800 Series, or approved equal.
5. Mounting stem shall be 1 inch diameter schedule 40 stainless steel cut to length and provided with a 2 inch male NPT interface and NEMA 4x wiring junction box.
6. Schedule:

TAG	DESCRIPTION	SETPOINT
LSLL-512	RAS Wet Well Low Level Float	84 inches

K. Level Transmitter – Free Space Radar – Indicating

1. The transmitter shall use advanced pulse radar technology to provide reliable level measurement in liquids and slurries.
2. The transmitter's construction shall be compact and robust and available with an epoxy-coated aluminum or stainless steel housing.
3. The transmitter shall provide reliable measurement in environments with harsh chemicals, steam, dust, encrustation, turbulence and agitation.
4. Additional features:
 - a. Built-in diagnostics
 - b. Various flanges, horn and waveguide antenna options available, coordinate installation with 6 inch flange unless otherwise noted.
 - c. Extremely high signal-to-noise ratio
 - d. Transmitter shall have a universal power supply (AC or DC) to power the unit unless otherwise noted.
 - e. Easy false echo suppression of fixed obstructions
 - f. Analog output: optically-isolated 4-20 mA into 450 Ω max., 0.02 mA resolution
 - g. Display (local): alphanumeric and multi-graphic liquid crystal for readout and entry
 - h. Accuracy at 20°C: ± 15 mm from 0.4 m to 10 m $\pm 0.15\%$ from 10 m to 20 m
 - i. Temperature drift: $< \pm 0.25\%$ of maximum range from -40 to 60°C (-40 to 392°F)
 - j. Repeatability: ± 2 mm (range < 3 m), ± 3 mm (range < 5 m) ± 5 mm (range < 10 m), ± 10 mm (range < 20 m)
 - k. Fail-safe: mA programmable high, low or hold upon LOE condition
 - l. Environmental location: indoor/outdoor, -40 to 60°C (-40 to 140°F)
 - m. Chemically resistant PTFE covered antenna suitable for 150% operational span.
5. Manufacturer: Siemens SITRANS LR300 (preferred), Endress+Hauser FMR245, Rosemount, or approved equal.
6. Schedule:

TAG	DESCRIPTION	NOTE	SPAN
LE/LIT-110	Influent Channel Level – Remote Controller	1.5 inch NPT	0-12 ft
LE/LIT-270-1	PEPS Wet Well No.1 Level	-	0-20 ft.
LE/LIT-270-2	PEPS Wet Well No.2 Level	-	0-20 ft.

LE/LIT-450	Filter Influent Channel Level	-	0-8.5 ft.
LE/LIT-512	RAS Wet Well Level	1.5 inch NPT	0-8 ft.

L. Pressure Transmitter – Indicating

1. “Smart” pressure transmitter, and microprocessor based digital transmitter with 1/4"-18 NPT process connections. The transmitter shall include local span and zero adjustment buttons or pots and have integral transient protection.
2. Sensor module shall have stainless steel body, Hastelloy-C diaphragm and silicone fill fluids.
3. Proper sensor shall be furnished for application; gauge, differential, absolute pressure measurement.
4. Provide a 4-20 mA analog signal proportional to process pressure.
5. Operating temperature of –20°F and 185°F.
6. Integral digital indicator for displaying process variables in Engineering Units.
7. Accuracy of $\pm 0.1\%$ of calibrated span.
8. Provide a stainless steel 3-way valve manifold to permit zero checks, calibration, and isolation of the transmitter.
9. Provide a three way valve manifold.
10. Transmitter housing shall be watertight, NEMA 4X , and corrosion resistant.
11. Wall mounting bracket for transmitter assembly by same manufacturer. Coordinate mounting requirements with Electrical Contractor and field conditions.
12. Manufacturers: Rosemount 3051, Smar, ABB, Endress & Hauser, Consolidated Electric, Honeywell, or approved equal.
13. Schedule:

TAG	DESCRIPTION	SPAN
PE/PIT-350-1A	IFAS Blower No.1 Suction Pressure	Coordinate with blower manuf.
PE/PIT-350-2A	IFAS Blower No.2 Suction Pressure	Coordinate with blower manuf.
PE/PIT-350-3A	IFAS Blower No.3 Suction Pressure	Coordinate with blower manuf.
PE/PIT-355-1A	Ex. Diurnal Blower No.1 Suction Pressure	Coordinate with blower manuf.
PE/PIT-355-2A	Ex. Diurnal Blower No.2 Suction Pressure	Coordinate with blower manuf.
PE/PIT-355-3A	Ex. Diurnal Blower No.3 Suction Pressure	Coordinate with blower manuf.

M. Temperature Switch

1. Temperature switches shall have a watertight NEMA 4X corrosion resistant housing.
2. The switch shall be SPDT snap-action, rated for 10 amps at 120VAC.
3. Switch shall include knob type adjustment with tamperproof cover. Process connection shall be 1/2" NPT.
4. Switch shall include variable adjustable deadband and repeatability of 1% of range.
5. Unless otherwise noted or required by application shall be, wetted parts brass.
6. Approved for UL, CSA and FM ratings

7. Manufacturer: Ashcroft L-Series Type 400, United Electric 100 Series, Dwyer, or approved equal.
8. Schedule:

TAG	DESCRIPTION	SET POINT
TSH-168	Screen Building Electrical Room Air Conditioning Failure	80 Deg. F
TSH-271	PEPS Electrical Room Air Conditioning Failure	80 Deg. F

N. Temperature Element/Transmitter – Process (RTD)

1. Temperature indicating-transmitters shall be microprocessor-based with "smart" electronics, capable of accepting direct inputs from 2-, 3-, or 4-wire, platinum, copper, or nickel resistance temperature detectors (RTD) from 10 to 1000 ohms, thermocouple inputs, direct millivolt sources, and resistance/potentiometer devices.
2. The indicating-transmitter shall be a true 2-wire device capable of operating on voltages up to 45 VDC
3. The accuracy of the transmitter's Digital-to-Analog converter shall be within ± 0.03 percent of span. Digital Accuracy (Pt100 RTD) shall be 0.15 degree C.
4. Operating temperature of -40°F and 350°F .
5. An LCD digital display shall be provided, capable of displaying mA, degrees in any engineering units. The indicating-transmitter shall contain an analog-to-digital converter which shall convert the RTD input to a digital signal. The electronics section shall correct the digital signal from the sensor and convert it into a 4-20 mA analog signal for transmission to receiving devices.
6. Output signal damping shall be provided, with an adjustable time constant of 0-36 seconds. Long Term Stability (frequency of calibration) shall be no less than 0.25% of Reading or 0.25 degree C for 2 years
7. The transmitter shall include local span and zero adjustment buttons or pots and have integral transient protection.
8. Transmitters installed in non-hazardous areas shall have a watertight NEMA 4X corrosion resistant housing.
9. Flat bracket for 2" pipe mounting of transmitter assembly by same manufacturer. Coordinate mounting requirements with Electrical Contractor and field conditions. 1/4"-18 NPT process connections.
10. Manufacturer/Model:
 - a. Rosemount 248
 - b. Or equal

TAG	DESCRIPTION	SPAN
TE/TIT-350-1	IFAS Blower No.1 Discharge Pressure	Coordinate with blower manuf.
TE/TIT-350-2	IFAS Blower No.2 Discharge Pressure	Coordinate with blower manuf.
TE/TIT-350-3	IFAS Blower No.3 Discharge Pressure	Coordinate with blower manuf.
TE/TIT-355-1	Ex. Diurnal Blower No.1 Discharge Pressure	Coordinate with blower manuf.
TE/TIT-355-2	Ex. Diurnal Blower No.2 Discharge Pressure	Coordinate with blower manuf.
TE/TIT-355-3	Ex. Diurnal Blower No.3 Discharge	Coordinate with

	Pressure	blower manuf.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor must obtain the services of a Control Systems Integrator (or a qualified technician) to configure, test and commission all instrumentation & controls specified herein.
- B. Examination
 - 1. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
 - 2. Examine roughing-in of instruments to verify the following:
 - a. Environmental conditions are within the limitations established by the manufacturer.
 - b. Each utility pipe and conduit is in the correct location.
 - 3. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
 - 4. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.
 - 5. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Install instruments as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions and recommendations.
 - 1. Supply, mount, install, wire, terminate, and configure all instrumentation, instrumentation equipment, and components as specified herein. Provide all necessary brackets and mounting hardware required by the instrument manufacturer for proper installation.
 - 2. Unless otherwise specified or required, supports shall be aluminum or stainless steel. All mounting hardware shall be stainless steel. Equipment mounted on walls in contact with soil or water shall be mounted offset from the wall a minimum of ¼-inch.
 - 3. Dissimilar metals shall not be connected, spliced, or joined
 - 4. Align, level and adjust for satisfactory operation. Install so that parts are easily accessible for inspection, operation, maintenance and repair. Instrumentation shall be mounted upright, vertical, at eye level, and in locations easily and safely accessible. Minor deviations from indicated arrangements may be made, but only after obtaining approval from the Owner's Representative.
- D. Electronic low-level signals (analog, discrete, and communications) shall be properly isolated, bundled and supported. These signals shall be routed and separated from AC power wiring.
 - 1. AC power, DC power/signal, and communication cables shall be installed in separate conduit systems, and shall be physically separated by a minimum of 12 inches.
 - 2. All "intrinsically safe" wires and cables shall be kept isolated and installed in separate wire channels and conduit systems from normal power and signal wires

- by at least two inches of space. Label wire channels and conduits “Intrinsic Wiring”.

E. Grounding

1. Equipment shall be solidly grounded with an equipment grounding conductor as specified in Section “Grounding” and as recommended by the manufacturer. Control panels and instruments shall be grounded at the power supply end using a ground wire pulled with the power wires.
2. All instruments and transmitters shall be grounded at the device’s power source using a ground wire pulled with the power wires. Metal cases of loop-powered instruments shall be grounded at the control panel powering the loop using a ground wire pulled with the twisted-shielded pair of wires. All transmitters and metal cases shall be grounded at the control panel with a ground wire. Grounding through conduit and fittings and to grounds other than that of the control panel are not acceptable.
3. The shield in twisted-shielded pairs shall be grounded at the power supply end. Meaning, 4-wire transmitters = ground at transmitter end, 3-wire transmitters = ground at power source end, 2-wire transmitters = ground at loop power source end.

F. Cutting and drilling of existing panels for new instrumentation as shown, specified, or required, shall include repair and touch up painting of panel after installation.

3.2 FIELD QUALITY CONTROL

A. Perform tests in accordance with the following standards:

1. NETA ATS.

B. Prepare for Acceptance Tests as follows:

1. After installing equipment but before power supply is energized, verify that grounding system is completed.
2. Verify that equipment is installed and connected according to the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing.
4. Verify that field-installed power and control wiring complies with the Electrical Specification requirements.
5. Verify that equipment is ready for pre-commissioning checks in accordance with manufacturer's written instructions.

C. Acceptance Tests: After installing equipment and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements as follows:

1. Perform visual and mechanical inspection and electrical tests according to NETA ATS, Section 7, as it applies to all installed systems and devices. Certify compliance with the following test parameters:
 - a. Circuit Breakers: Perform tests and inspections stated in NETA ATS, Section 7.6.
 - b. Protective Relays: Perform tests and inspections stated in NETA ATS, Section 7.9.

- c. Instrument Transformers: Perform tests and inspections stated in NETA ATS, Section 7.10.
- d. Metering and Instrumentation: Perform tests and inspections stated in NETA ATS, Section 7.11.
- e. Ground-Fault Systems: Perform tests and inspections stated in NETA ATS, Section 7.14.
- f. Surge Arresters: Perform tests and inspections stated in NETA ATS, Section 7.19.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Markup and sign Loop Diagrams

3.3 MANUFACTURER'S FIELD SERVICES

- A. Engage a factory-authorized service representative to perform the following inspections, checks, and supervision of testing:
 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with the manufacturer's installation recommendations and requirements. Any required mounting, installation, and wiring corrections or adjustments shall be performed at no additional cost to the Owner.
 2. Set field-adjustable settings to the values recommended by the equipment manufacturer.
 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and components.
 4. Supervise tests performed by independent testing firms. Witness initial energization and perform or supervise startup services.
 5. Prepare written report to record the following:
 - a. Inspections and checks carried out on site.
 - b. Test procedures used.
 - c. Test results that comply with requirements.
 - d. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.4 OPERATION & MAINTENANCE MANUALS

- A. The Contractor shall prepare four (4) Operation & Maintenance Manuals as specified in the General Specifications, consisting of equipment manufacturers' O&M manuals, user manuals, installation instructions, configuration instructions, etc., and specified hereinafter. Each shall include:
 1. Index and tabbed section dividers ordering instruments into logical arrangements.
 2. The information for each instrument should include:
 - a. The part number of the installed instrument.
 - b. All tag numbers associated with the associated part number
 - c. O&M specific to the installed instruments.
 - d. Reviewed submittals.
 - e. Calibration information: Manufacturer's calibration certification, field calibration data and field calibration check data as applicable
 - f. Manufacturer's Field Start-up reports as applicable
 - g. Manufacturer's instructions on care and operation of equipment.

- h. Warranty certificates.
 - i. Spare parts list.
 - j. Name, address and telephone number of supplier and representative of manufacturer for each item of equipment in Contract.
 - 3. Wiring diagrams.
 - 4. Field adjustable settings (e.g. setpoints, ranges, spans current alarm trips)
- B. Bind above items (all unused, clean, and legible) in three ring binders and submit to the Owner's Representative for review and approval. Provide all required copies of reviewed and approved portfolios before request for final acceptance.

3.5 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment.
 - 1. See Section 01 79 00 – “Demonstration and Training”
 - 2. Train Owner's maintenance personnel for a minimum of 4 hours each type of field instrument for energizing and de-energizing, troubleshooting, servicing, and maintaining equipment and schedules.
 - 3. Review data in Operation and Maintenance manuals with plant staff.
 - 4. Schedule training with Owner, with at least 14 days advance notice.

3.6 FOLLOW-UP SERVICE

- A. Monitoring and Adjusting: After Substantial Completion, but not more than twelve months after Final Acceptance, perform the following monitoring and adjusting tasks:
 - 1. Replace failed and defective equipment (under warranty).
 - 2. Recalibrate and reconfigure as necessary.
 - 3. Retest and adjust as necessary.

* * * * *

SECTION 40 91 31

COMPOSITE SAMPLING SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing wastewater sampling equipment complete with all appurtenances as indicated in accordance with the Contract Documents.

1.3 QUALITY ASSURANCE

- A. The manufacturers shall be experienced in the design and construction of equipment for this purpose, and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than five (5) years.

1.4 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:
Secondary Clarifier Influent Sampler

1.5 SUBMITTALS

- A. Submittals shall conform to the General and Supplementary Conditions and Division 01.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.
- C. The following items shall also be submitted in accordance with the requirements of the General and Supplementary Conditions and Division 01:
 - 1. Shop drawings for the sampling equipment, including the following.
 - a. Parts list with materials of construction.
 - b. Equipment and controls.
 - c. Schematic wiring diagrams.
 - d. Complete control system and equipment description.

- e. Spare parts list.
- 2. Catalog data for the sampling equipment.
- 3. Manufacturer's installation recommendations.
- D. Submit Operation and Maintenance Manuals in accordance with Division 01. In addition to other required information, include recommended spare parts list, and list of special tools required for checking, testing, parts replacement, and maintenance.
- E. Submit Manufacturer's Certificate of proper installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The project design is based on Teledyne Isco, Inc. as listed in this Section.
- B. Acceptable manufacturers
 - 1. Teledyne Isco, Inc (5800 Refrigerated Sampler)
 - 2. Or approved equal

2.2 FUNCTIONAL DESIGN

- 1. The automatic refrigerated wastewater sampler shall be furnished for sequential and composite sampling applications, and shall be suitable for indoor or outdoor installation without the requirements for additional enclosures for weather protection. The sampler shall be capable of collecting samples from a variety of liquid sources including open channels, sewers, and stormwater conduits. The sampler will route samples to storage containers for collection and off-site analysis. The sample stream will be a direct path from sample source to sample bottle. Samples will not pass through metering chambers or other diversions. The sampler shall be suited to collect priority pollutant or general purpose samples in multiple bottles or a single bottle. The sampler will be line (AC) powered (115 volt 60Hz).
- 2. Refrigerator
 - 1. The refrigerator shall cool to a setpoint selectable from 34 to 48°F (1 to 9°C), with a setpoint stability of ± 1 °C over a 48 hour period.
 - 2. The refrigerator shall have a 5 minute typical recovery time to return to 39°F (4°C) after the door has been opened for 1 minute in 75°F (24°C) ambient conditions.
 - 3. The collected samples shall be stored in an enclosure capable of operating in ambient temperatures from -20°F to 120°F (-29° to 49°C).
 - 4. Built-in heaters shall prevent collected samples from freezing if the ambient air temperature drops below freezing.

5. For single bottle composite sampling only, the refrigerator can, upon program initiation, drop the temperature within the sample compartment by 2.5° C below the set temperature for the first 24 hours of operation before resuming normal operation.

3. Controller

1. The sampler's memory shall maintain the program settings, stored programs, and the results of the last two sampling sequences when the sampler is turned off or an external power interruption occurs.
2. A user-initiated diagnostics routine shall indicate the operational status of the sampler. The controller will display any error conditions detected by the diagnostic routines.
3. The current refrigeration temperature shall appear on the sampler's display, and temperature readings shall be stored in a report.
4. The controller shall be able to automatically switch input power to a connected Isco battery in the event of a loss of AC power.
5. Sample volumes shall be selectable between 10 and 9,990 ml in 1ml increments.
6. The sampler shall be capable of being programmed to rinse the suction line with the source liquid up to three times.
7. The sampler shall typically deliver sample volumes with an accuracy of ± 10 ml or $\pm 10\%$, whichever is greater, of the programmed value. The typical sample volume repeatability shall be ± 5 ml or $\pm 5\%$, whichever is greater, of the average of the maximum and minimum sample volume in the sample set.
8. The sampler shall collect sequential or composite samples at user-definable intervals and volumes. A delay to first sample collection shall be programmable by the real-time clock.
 - i. Time Pacing
The sampler will use an internal real-time clock to provide time and date information. Uniform time-paced samples shall be collected at regular time intervals from 1 minute to 99 hours 59 minutes. Sample volumes may be equal or variable in proportion to flow.
 - ii. Flow Pacing, DC Pulse
The sampler shall accept a 5 to 15 VDC flow proportional pulse or isolated dry contact closure, at least 25 ms in duration, from an external flow meter for flow pacing. Samples shall be equal in volume and shall be taken at variable times proportional to flow. The number of flow pulses shall be selectable, from 1 to 9,999 pulses, as the flow interval for each sample collection.
 - iii. Flow Pacing, Analog Input
The sampler shall have a standard 4-20mA flow proportional input compatible with most flow meters without additional interfacing. Samples shall be equal in volume and shall be taken at variable times proportional to flow.
 - iv. Flow-Weighted Volumes, DC Pulse
The sampler shall accept a 5 to 15 VDC flow proportional pulse or

isolated dry contact closure, at least 25 ms in duration, from an external flow meter. Samples shall be taken at equal time intervals, and variable sample volumes shall be proportional to cumulative flow.

v. Flow-Weighted Volumes, Analog Input

The sampler shall have a standard 4-20 mA flow proportional input compatible with most flow meters without additional interfacing. Samples shall be taken at equal time intervals, and variable sample volumes shall be proportional to cumulative flow.

9. The sampler shall have 3 selectable modes of sample distribution.

vi. Samples per bottle mode: The sampler shall be capable of placing a sample volume from one or more sample events in a bottle.

vii. Bottles per sample mode: The sampler shall be capable of filling all sample bottles with a single initiation.

viii. Multiple bottle composite mode: The sampler shall be able to simultaneously create a user-selected set of bottles for depositing of multiple samples, switching bottles after a programmed period of time has elapsed, or a programmed number of samples has been collected.

10. Sampler Outputs

ix. The sampler shall have four standard digital alarm outputs capable of direct wiring to a Programmable Logic Controller (PLC) or data logger (5 volt, 100 mA).

x. Output alarms shall include: Program started, Program completed, Pump error, Distributor jammed, 3-way valve control, Taking sample, Pumping forward, Powered up, Pumping reverse, Bottle full, and Delay before sample.

xi. The sampler shall output an event mark of 12VDC for a duration of 3 seconds, beginning at the start of forward pumping, from the flow meter connector.

xii. The sampler shall store a one-minute temperature data report retrievable by an IBM-compatible computer using a terminal emulator tool such as Tera Term (not provided by Teledyne Isco). The program shall include failsafe loading with site ID codes to prevent field errors due to multiple files.

4. Pump

Samples will be collected via a peristaltic pump. This pump shall produce typical line velocities of 3.0 feet per second in a 3/8 inch (0.95 cm) ID suction line at 3 feet (1 m) of head. At 25 feet (7.6 m) of head, the pump shall typically produce a line velocity of 2.2 feet (0.67 m) per second. The pump shall be capable of lifting a sample a maximum of 28 feet (8 m).

i. Before and after each sample is collected, the pump shall air-purge the suction line. Pre-purges and post-purges will be automatically controlled, and no pre-calibration adjustments are required.

ii. With the opening of the pump's latch and band, all power will be removed from the sampler's pump motor, to eliminate the possibility of a pump activation injuring personnel.

- iii. The liquid detection system shall minimize the effects of changing head, intermittent flow in the suction line, or variable battery conditions on sample volume.
- iv. After initial detection of liquid, the sensor shall monitor for the presence of liquid during the sample collection sequence. In composite mode without use of a distributor arm, this feature can be used for full bottle detection during the post-purge cycle.
- v. The liquid detector shall monitor for anomalies in the sample collection process. If no liquid is detected, the sampler shall be capable of retrying the sampling sequence up to three times.
- vi. After liquid detection, the pump revolution counter shall count actual pump revolutions to determine sample volume delivery to the storage containers. If liquid flow is interrupted during the sample collection sequence, the detector shall inhibit the pump revolution counter from incrementing until liquid flow is restored. Automatic compensations for air slugs in the sample shall be made by the delivery system. Additionally, the pump revolution counter shall monitor the total number of pump revolutions and alert the user when a pre-selected number of counts has been reached to alert the user of the need for pump tubing replacement. One pump revolution is equivalent to 12 pump counts. This indicator shall appear on the controller display screen.

2.3 EQUIPMENT DESCRIPTION

A. Sampler

- 1. The top section housing the control panel, pump, distributor electronics, and power supply box shall be rated NEMA 4X, 6, and IP 67.
- 2. The sampler shall include long-life electronic temperature sensing devices that measure the refrigeration compartment and evaporator plate temperatures. A microprocessor will utilize this sensor to control operation of the compressor, built-in heaters, and the self-defrosting cycle of the evaporator plate.

B. Refrigerator

The shell of the refrigerator shall be constructed of rotationally molded UV-resistant polyethylene with molded-in-place thermal insulation, providing exceptional resistance to corrosion and weathering. The top of the refrigerator door shall be recessed for ease of access from above. For 24 bottle configurations, the bottle rack shall slide out for ease of sample recovery. The copper refrigeration lines, condenser coil, and evaporator plate will be powder-coated with heat-treated polyester, and then painted with a rust converter paint overcoat, for additional corrosion resistance.

- 1. The refrigerator's door shall have hasps capable of accepting a padlock to prevent unauthorized tampering with the sample compartment contents. A compression gasket will be used to seal the refrigerator door. The refrigerator power supply and solid-state thermostat shall be contained in an epoxy-potted enclosure housed in a discrete compartment of the sampler's molded frame.

All exposed metal components used in the construction of the refrigeration system shall be either plated aluminum or stainless steel.

2. The refrigerator will use a condensing coil with forced-air cooling.
3. The compressor is rated at (1/5 Hp for 115V)
4. The refrigeration system will contain HFC-134a refrigerant, a non-CFC refrigerant with an ozone depletion potential of zero.

C. Controller

1. The controller shall be housed in a discrete compartment of the sampler's molded frame beneath a flip cover.
2. The controller will show sampler status and program information via a 2-row, 20-column, 40 total character display. This display shall be angled for easy viewing, and backlit for easy use in all light conditions. All programming and manual control of the sampler will be entered via an 18 position keypad.
3. The controller shall not require a separate heater.
4. Pump
 - i. The modular peristaltic pump shall be housed in a discrete compartment of the sampler's molded frame, beneath a latched cover. The pump casing shall be constructed of high strength Noryl plastic and designed for corrosion resistance.
 - ii. The pump shall include a latched housing cover and thumbscrew opening for the replacement of pump tubing. The pump shall include a built-in magnetic safety interlock.
 - iii. The pump shall include a heater, housed beneath the pump cover, for the prevention of liquid freezing inside the pump under extremely cold conditions.
 - iv. Liquid Detector

The sampler will sense the presence of the liquid via a non-wetted, non-conductive detector. The sensor shall not be dependent on, or affected by, any chemical or physical property of the liquid or its contents. The sensor shall not require routine maintenance or cleaning.
 - v. The pump tubing used shall be specially treated to minimize water extractable pollutants. Specially designed bands shall indicate the correct placement of the tubing inside the pump. The tubing shall typically last for a minimum of 1,000,000 pump counts.

D. Distributor

The modular distributor shall be housed in a discrete compartment of the refrigerator's molded frame. Sample distribution will be belt-driven by a stepper motor. Positive location of the distributor arm will be achieved using an optical sensor. One of two available fixed-length distributor arms will be used for all bottle configurations and sampler mounting possibilities. The distributor arm may be moved by hand for ease of sample recovery, and shall relocate itself before the next sample is taken.

E. Suction Lines and Strainers

The sampler will utilize a suction line and strainer for taking samples. The suction

line shall be made of 3/8 inch (.95 cm) ID PTFE lined polyethylene with a length of 99 feet. The suction line shall have a factory-installed standard 3/8" weighted polypropylene strainer.

F. Sample Collection Containers

The sampler shall be supplied with sample collection container(s). The container(s) shall be round 20L polyethylene. The sampler shall be provided with at minimum, this container, two caps and two discharge tubes.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The Contractor shall install all equipment in accordance with the manufacturer's recommendations. The Contractor shall make all necessary adjustments to equipment to provide complete operational sampling system.

3.2 FIELD QUALITY CONTROL

A. Pre-test Checkout

1. Prior to installation of samplers and connections to respective process locations, place the samplers in the blower room or an alternate room where the room temperature can be raised to approximately 90 degrees F. Fill sample containers with water and demonstrate that the refrigerator maintains the specified temperature on the basis of temperatures read hourly for the first eight hours and temperatures read after 24 and 25 hours.
2. After permanent installation of samplers, demonstrate manual control functions.
3. Demonstrate local manual and automated control functions per manufacturer's operating instructions.
4. The pump shall be visually inspected by the manufacturer's representative to confirm that it is built and installed in accordance with the specification as to HP, voltage, phase and Hertz.

B. Performance Testing

1. Sampler units shall be run for two 24 hours cycles during the Plant Circulation Test to demonstrate satisfactory sample collection and sample frequency.

3.3 MANUFACTURER'S SERVICES

- A. The services of a qualified representative of the manufacturer for the samplers and the sampling pump shall be provided to inspect each installation of the equipment, make necessary adjustments, and instruct the operating personnel about operation and

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maintenance. A minimum of 16 hours of services shall be provided for the sampling equipment.

- B. The service visit for operational training shall be scheduled in coordination with the Owner's operations staff and shall be at such times as requested by the Owner.

* * * * *

SECTION 40 92 13.13

ELECTRICALLY-OPERATED PRIMARY CONTROL VALVES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing electric valve operators, remote control stations, control station padlocks, and related accessories as indicated in accordance with the Contract Documents.

1.3 SUBMITTALS

- A. Submittals shall be submitted in accordance with the conditions set forth in the General and Supplementary Conditions and Division 01.
- B. The valve manufacturers shall be responsible for furnishing the valve operators. Valve operator shop drawings shall be submitted with each valve submittal.
- C. Submittals for equipment and materials shall be clearly marked or noted with specific features, standard options, and wiring diagrams to indicate compliance with Contract Documents.
- D. Where deviations to Contract Documents are proposed, submit a list of deviations. Provide a detailed description and explanation for each deviation.
- E. The contractor shall submit design calculations for sizing and operation of the electric actuators.
- F. Submit a coordination list which identifies each electric actuator and its associated valve. The coordination list shall include project specific information such as valve tag numbers, valve type, size, load requirements, and application.
- G. Shop drawings shall present complete and accurate information relative to all working dimensions, equipment weights, assembly, and section views, and all necessary details pertaining to coordinating the Work of the Contract. Shop drawings shall contain information such as special tools and other items of information that are required to demonstrate detailed compliance with the Contract Documents.
- H. Submit shop drawings which shall include the following:

1. Bill of Materials for all equipment and accessories.
 2. Manufacturer's catalog information for all components and accessories.
 3. Manufacturer's standard wiring diagrams including all available terminal connections.
 4. Project specific wiring interconnection diagrams showing all field termination points to remote equipment. Submittals without project specific wiring diagrams will be rejected. This shall include detailed wiring diagrams showing conductors and field terminations between valve operators, power supply connections, field inputs/outputs, and remote control stations.
 5. Spare Parts List (including specified spare parts to be furnished by the Contractor and manufacturer's recommended spare parts list for each type of unit).
 6. Project specific installation instructions and mounting details for piece of equipment. Materials of construction for supports, brackets, and mounting hardware shall be provided with details.
 7. Shop Drawings including electric actuator, gear ratio, performance charts, size, parts list, as required, for electric actuator.
- I. Provide Factory Performance Test Report including information specified.
 - J. Submit Operation and Maintenance Manuals for the electric actuators in accordance with The General and Supplementary Conditions and Division 01.

PART 2 PRODUCTS

2.1 GENERAL

- A. The valve operator shall include an electric actuator as specified. The operator shall be provided with all appurtenances necessary for the equipment to perform its intended function. Appurtenances for the electrical actuators shall include anchor bolts, hardware, control switches, limit switches, torque switches, electrical supply connections, internal electric wiring and controls, regulating controls, position potentiometers, push button controls, miscellaneous controls, extension stems, local indicators, operating nuts, and indicating lights.
- B. The valve manufacturer shall be responsible for furnishing the valve operators. The valve operator shall be coordinated with and shall be compatible for operation with each valve supplied. The valve manufacturer shall be responsible for coordinating the specific requirements of the valve operators with the valve operator manufacturer.

2.2 ELECTRIC ACTUATORS

A. General

1. The following electric actuator requirements are applicable for motor operated valves unless otherwise noted.
2. Electric actuators shall include the motor, integral reversing starter, actuator unit gearing, local control facilities, position limit switches, torque switches, declutch lever, and crank, as a self contained unit. Remote control stations shall be provided where specified herein or as where shown on the Contract Drawings. Components and accessories shall be provided by a single source manufacturer.
3. Electric actuators shall be fully compatible with the valves and operating stems. Electric actuators shall either be quarter-turn or multi-turn as required for each specific valve application and shall be sized to provide the torque requirements of the valves being served.
4. Electric actuator mounting configurations shall be coordinated with each valve application. Provide mounting bases and drive output couplings as required to interface with each valve.
5. Actuators shall be factory wired requiring only connections of power supply, control circuits, and remote control stations where applicable.
6. Electric Actuators shall meet the latest revision of the applicable AWWA Standard C504-87 and C540-93.
7. Electric Actuators shall be provided as scheduled below:

<u>Valve Tag No.</u>	<u>Description</u>	<u>Voltage</u>	<u>Control Mode</u>	<u>Remarks</u>
	Primary Activation Recycle Valve	480V	E	2
	Oxic Butterfly Valves No. 1-3	480V	C	4
	DeOx Butterfly Valves No. 1-3	208V	C	4
	Chapman Valve	480V	A	3
	Influent Screw Pump Influent Gate No. 1	480V	A	3
	Influent Screw Pump Influent Gate No. 2	480V	A	3
	Fine Screen Bypass Inlet Gate	480V	A	3
	Fine Screen Bypass Outlet Gate	480V	A	3
	PEPS Discharge Plug Valve No. 1	480V	B	
	PEPS Discharge Plug Valve No. 2	480V	B	
	PEPS Discharge Plug Valve No. 3	480V	B	
Reference Notes:	1. Provide Extended Valve Stem 2. Remote Control Station 3. Actuator shall be designed and listed for installation in Class 1, Group D, Division 2, Hazardous Locations			

<u>Valve Tag No.</u>	<u>Description</u>	<u>Voltage</u>	<u>Control Mode</u>	<u>Remarks</u>
	4. Refer to Contract 1 for valves supplied by the Owner (under Contract No. 1), but installed by Contract No. 2 5. Install motor operator a minimum of 2 feet above top of grating elevation to stay outside of hazardous envelope			

B. Valve Coordination

1. Actuator Sizing

- a. The actuator shall be sized to allow valve closure at the required differential pressures. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal.
- b. Electric actuators shall be sized to fully open or close each valve in a period of time no greater than 60 seconds. Operation times on all gates should be at least 12 inches per minute.

C. Electric Actuator Construction

1. The motor, gearing, controls and auxiliary components shall be housed in a NEMA 4, NEMA 4X or NEMA 6 enclosure, provided with a corrosion protective finish.
2. Gear Reduction
 - a. Electric actuators shall be furnished with gear reduction as required per each specific valve application. Gears shall be machine cut, ground and highly polished. Shafts shall be heat-treated steel. The output or driving shaft shall operate in bronze bearings or in ball or roller bearings.
 - b. The actuator gearing shall be totally enclosed in oil or grease filled gearcase to permit the actuator to be mounted and operated in any position. The gearcase shall be constructed to allow field inspection without taking the valve out of service.
 - c. Combined gear ratio shall ensure “self-locking” characteristics at all times and shall be of sufficiently high ratio as to inhibit “back driving” the actuator.
3. Drive Bushing
 - a. The actuator shall be provided with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. Thrust bearings when required shall be housed in a separate thrust base and be a sealed for life design.

4. Handwheel Operator

- a. Each actuator shall be provided with a handwheel operator and declutch lever. The declutch lever shall disengage the motor operator and engage the handwheel operator such that the valve can be open and closed manually. Handwheels shall be so designed that the motor does not turn when the handwheel is engaged and automatically disengages when the motor is energized. Handwheels shall be sized adequate to manually operate with handwheel effort not exceeding 80 pounds. The handwheel operator clutch mechanism shall be designed to permit padlocking in both the engaged and disengaged positions.
- b. It should be possible to select manual operation while the actuator is running or start the actuator motor while the lever is in manual without damage to the drive train.
- c. The handwheel drive shall be mechanically independent of the motor drive, and gearing shall permit emergency manual operation in a reasonable time.
- d. A clockwise rotation of the handwheel shall provide a clockwise rotation of the output drive sleeve.

5. Motor and Motor Protection

- a. For multi-turn actuators, electric motors shall be single-phase or three-phase as scheduled, squirrel cage induction type, specifically designed for valve actuator service. The motors shall be of totally enclosed, non-ventilated construction. (Ad No. 10)
- b. Electric motors shall be low inertia, high torque type, and with Class F or H insulation with a Class B temperature rise.
- c. Overload protection shall be by means of inherent motor thermal sensors embedded in the motor windings.
- d. Torque protection reset shall not allow repeated starting in the same direction while the control signal is maintained.
- e. Three-phase motors shall be protected against single phasing and shall be provided with automatic phase correction.
- f. For quarter turn actuators, motors shall be brushless DC type with solid-state motor thermistor to prevent damage due to temperature overloads. (Ad No. 10)

6. Mechanical Position Indicator

- a. Actuators shall be provided with a local mechanical position indicator or lever which shall track the valve position and provide a visual reference, requiring no electric components. The mechanical position indicator shall be colored red and located on each valve in a position where it can be easily viewed from a minimum of 6 feet away.

7. Electronic Position Indicator

- a. Actuators shall be provided with an optical encoder to electronically monitor valve position. The actuator shall be provided with a digital position indicator located on the actuator control panel. The digital indicator shall display from the fully open to the fully closed positions in 1% increments.
- b. The encoder shall monitor the position of the valve at all times, including both motor operation and handwheel operation.

8. Space Heaters

- a. Electric actuators shall be provided with space heaters to minimize condensation build-up inside the actuator enclosures. The actuator shall be provided appropriate power supply and controls for powering and controlling the space heaters. Separate dedicated power supplies shall not be required.

9. Torque Sensing

- a. Each actuator shall be provided with both open and close torque protection. A microprocessor shall calculate the output torque from motor speed, voltage, and temperature. Torque limit shall be set from 40-100% of rating in 1% increments. The torque sensor shall not monitor the starting sequences of the actuator during initial valve unseating.
- b. Torque sensing shall be performed electronically.

D. Power and Controls

1 General

Power and control wiring shall join at a terminal strip in a separate watertight terminal box. The terminal box shall be provided with minimum two separate NPT-threaded conduit entries (minimum $\frac{3}{4}$ ").

2. Controls

- a. Electrical controls shall include reversing motor starters, control power transformers and integral and /or remote control stations which shall be provided with each actuator.
- b. Motor starters shall be suitable for a minimum of 60 starts per hour, and shall be rated for the motor size.
- c. Electric actuators shall include provisions for interfacing with remote control, dry contact input signals for remote OPEN/STOP/CLOSE operation of the actuator. Remote signals shall be momentary, dry type contacts.
- d. Electric actuators shall be provided with integral control stations which shall include the following features:
 - (1) Local-Off-Remote Selector Switch (with provisions for pad-locking in any position). Selector switch shall be provided with one extra contact for remote monitoring of the selector switch "remote" position. Contacts shall be factory wired to terminal blocks to facilitate field wiring connections.
 - (2) Open-Stop-Close Pushbuttons (Momentary)
 - (3) Open "RED" Indicating Light
 - (4) "YELLOW" Fault Light
 - (5) Closed "GREEN" Indicating Light

Open and Closed indicating lights shall be energized when the electric actuator is in the respective "Full Open" or "Full Closed" positions. The indicating lights shall both be energized when the electric actuator is in between the "Full Open" and "Full Closed" positions.

 - (6) The actuator shall be provided with a digital position indicator located on the actuator control panel.
- e. Remote Control Stations shall be provided with the same functions as the integral control stations listed above. The remote control station location must be readily accessible to operators for use and mechanics for maintenance. The remote control station shall be powered from the actuator internal power supply. Remote control stations shall be provided with NEMA 4X enclosures. Electric actuators provided with remote control stations do not require integral controls. Blank off panels may be provided as long as the remote control station can provide configuration of each unit. The

actuator manufacturer shall provide all interconnecting wiring, cables, wire harnesses, and connections between the electric actuator and the remote control station. Provide control stations if actuators are unreachable without a ladder or are in inaccessible locations.

- f. Four auxiliary limit switches shall be provided and shall be geared and fully adjustable to trip at any point between fully opened and fully closed. These limit switches shall be provided in addition to limit switches required for the integral valve controls. The auxiliary limit switches shall be factory set; 2 at fully closed position and 2 at fully open position. Limit switch contacts shall be factory wired to terminal blocks to facilitate field wiring connections.
- g. The actuator shall be provided with integral torque overload protection.
- h. The actuator shall be provided with integral diagnostic capabilities for monitoring the actuator operating conditions. The actuator provided with a common alarm relay output which shall monitor the following alarm functions as a minimum.

- (1) Valve Jammed
- (2) Motor Over-temperature
- (3) Motor Over-torque
- (4) Lost Phase (three-phase operators only)
- (5) No analog signal
- (6) Hardware failure

- i. Actuator Position Transmitter

The actuator shall be provided with an integral contact-less position transmitter which shall transmit a 4-20 mA analog signal directly proportional to the valve position.

3. Electric Actuator Modulating Controller

- a. Electric actuators specified for modulating service shall be provided with electronic position controllers to control the valve position to a 4-20mA analog input signal.
- b. Positioning shall be accomplished by comparing the command signal to an internal position feedback. The internal feedback shall be of the non-contacting type. The electronic controller shall be provided with a pulsing mode to prevent overshoot at the set point.
- c. Modulating electric actuators shall be provided with solid-state reversing motor starters suitable for 600 starts per hour.

- d. Modulating electric actuators shall be provided with the following features:

<u>Parameter</u>	<u>Description</u>
Accuracy:	±1.0%
Proportional Band:	Range from 1% to 100%
Dead Band:	Range from ±1% of proportional band.
Polarity:	20mA Open, 4mA Close
Fail Mode:	Go to Open, Close, or Stop (Field Adjustable)
Motion Inhibit Timer:	0 – 60 seconds (Field Adjustable)
Input Signal:	4-20mA (250 ohms)

4. Electric Actuator Control Mode Configuration

- a. Type “A” - Open & Close Control

LOCAL - When in the LOCAL position, the electric actuator shall move the valve continuously to the full open, full closed, or stopped position in response to the integral control station OPEN/CLOSE pushbuttons, or until the STOP pushbutton is depressed.

REMOTE - When in the REMOTE position, the electric actuator shall move the valve continuously to the full open or full closed position in response to the remote momentary, dry contact input signals, or until the LOR is switched to the OFF position.

- b. Type “B” – Jogging Control

Type “B” control shall be used for positioning the motor operated valves to manually control process flow rates.

LOCAL - When in the LOCAL position, the electric actuator shall move the valve in response to the integral control station OPEN/CLOSE pushbuttons. The valve shall operate only as long as the pushbuttons are depressed.

REMOTE - When in the REMOTE position, the electric actuator shall move the valve in response to the remote dry contact input signals, or until the LOR is switched to the OFF position.

- c. Type “C” – Modulating Control

LOCAL - When in the LOCAL position, the electric actuator shall move the valve continuously to the full open, full closed, or stopped position in response to the

integral control station OPEN/CLOSE pushbuttons, or until the STOP pushbutton is depressed.

REMOTE - When in the REMOTE position, the electric actuator shall move the valve in proportion to the 4-20mA analog input signal.

d. Type “D” – Modulating Control

For the Type “D” modulating control, the LOCAL/REMOTE switch located at the integral control station shall be set to the “REMOTE” position. The valve integral controls shall be duplicated at the remote control station. The following operational descriptions are based on the position of the LOCAL/REMOTE switch at the remote control station:

LOCAL - When in the LOCAL position, the electric actuator shall move the valve continuously to the full open, full closed, or stopped position in response to the remote control station OPEN/CLOSE pushbuttons, or until the STOP pushbutton is depressed.

REMOTE - When in the REMOTE position, the electric actuator shall move the valve in proportion to the 4-20mA analog input signal.

e. Type “E” – Position Control

LOCAL - When in the LOCAL position, the electric actuator shall move the valve continuously to Position 1 (outlet A full open/outlet B full closed) or Position 2 (outlet A full closed/outlet B full open) in response to the integral control station OPEN/CLOSE pushbuttons, or until the STOP pushbutton is depressed.

REMOTE - When in the REMOTE position, the electric actuator shall move the valve continuously to the Position 1 or Position 2 in response to the remote momentary, dry contact input signals, or until the LOR is switched to the OFF position.

5. Input/Output Summary

a. Each electric actuator shall accommodate the following input and output wiring connections.

<u>Parameter</u>	<u>Description</u>
LOR Switch Mode:	Discrete Output
Remote Open	Discrete Input
Remote Close	Discrete Input

<u>Parameter</u>	<u>Description</u>
Limit Valve Open 1	Discrete Output (Position Adjustable)
Limit Valve Open 2	Discrete Output (Position Adjustable)
Limit Valve Closed 1	Discrete Output (Position Adjustable)
Limit Valve Closed 2	Discrete Output (Position Adjustable)
Position Control	Analog Input (Modulating Valves Only)
Common Alarm:	Discrete Output – Common alarm for any valve malfunction.
Position Monitor	Analog Output (As shown on the Instrumentation Drawings)
Remote Control Station:	Valve manufacturer shall provide all interconnecting wiring, cables, wiring harnesses, and connections between the electric actuator and the remote control station.

E. Spare Parts

1. The following spare parts shall be provided for each electric actuator furnished for this project.
 - a. Bearing, O-Rings, and Seals
 - b. Actuator approved oil.
2. The following spare parts shall be provided for each type of actuator furnished for this project.
 - a. One Electronic Control Module (including each PC board) of each type provided.
 - b. One Main Contactor of each type provided
 - c. One Motor
 - d. One Relay
 - e. One Encoder
 - f. One stem nut
 - g. One worm shaft assembly
 - h. One drive sleeve assembly

F. Acceptable Manufacturers

1. Electric motor operators for quarter-turn applications shall be as manufactured by:
 - a. Rotork
 - b. Auma
 - c. Or approved equal

2. Electric motor operators for multi-turn applications shall be as manufactured by:
 - a. Rotork
 - b. Auma
 - c. Or approved equal

2.3 SMALL VALVE MOTOR OPERATORS

- A. All electric actuators for small valves shall have a thermally protected, bi-directional (reversing type), capacitor run motor with a permanently lubricated gear train. 115 VAC motors shall conform to CE and be indicated on motor housing. Provide heater/thermostat option.
- B. Actuator shall have a Zytel FR50 engineered resin housing with stainless steel trim, which meets NEMA Type 4X.
- C. Provide dry contacts for remote monitoring of open and closed, rated 10A and 120V. Shall accept 120V remote signals for open and close.
- D. Each actuator to have a declutchable manual override, visual position indication, ISO mounting configuration, and be RoHS compliant.
- E. Valves shall be Series 92 as manufactured by Asahi/America Inc. or approved equal.

2.4 PADLOCKS

- A. Padlocks shall be provided to lock each control station's Local-Off-Remote selector switch in any of the three positions. Padlocks shall be suitable for outdoor, severe weather use and shall be provided with the following features:
 1. Boron alloy-steel shackles which repel saws and bolt cutters.
 2. Dual locking shackles shall resist forcing or prying.
 3. Pick resistant spool pins.
 4. Durable thermo-plastic cover to protect lock body and key cylinder from dirt, dust, and other contaminants.
 5. Special drain channels to move water through the lock body.
 6. 2-1/8 inch wide steel case and five pin W6000 removable cylinder.
- B. Padlocks shall be "keyed alike" such that all locks can be opened via the same key number. Provide padlocks and 10 keys for this project.
- C. Manufacturers
 1. Master - Pro-Series 6121
 2. Or approved equal

PART 3 EXECUTION

3.1 INSTALLATION

- A. The installation of the electric actuators shall be in accordance with the configuration shown on the Contract Drawings, manufacture's template, and shop drawings.

3.2 TESTING

A. Factory Tests

1. Provide a factory performance test for each motor operated valve assembly. The test shall consist of simulating each typical valve load and the following parameters shall be recorded:
 - a. Current at maximum torque setting
 - b. Torque at maximum torque setting
 - c. Flash Test Voltage
 - d. Actuator Output Speed or Operating Time

In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

2. Provide a factory control and status test on each motor operated valve assembly by simulating each control signal and each position limit switch signal to verify proper and correct unit action.
3. Provide certified documentation of the tests performed. Final approval of the actuators shall be contingent upon receipt of the certified tests.
4. Provide above stated tests in addition to the normal factory tests performed.

B. Inspections & Field Calibrations

1. Visually inspect delivered units and accessories for conformance with the specifications and Contract Drawings.
2. Examine equipment locations for satisfactory preparation. Check conduits and raceway installations, and all wiring and cable terminations.
3. Perform startup of equipment under technical direction of manufacturer's service engineer. Under no circumstances shall any portion of the equipment be energized without authorization from the manufacturer's service engineer.

4. Manufacturer's service engineer shall program and calibrate each unit. Submit a startup configuration/parameter report for each drive. Report shall include the following information as a minimum:

Report shall include the following information as minimum:

- a. Project Name
- b. Equipment Location
- c. References
- d. Tag Reference
- e. Manufacturer/Model
- f. Manufacturer Serial Number
- g. Test Equipment Type and ID Number
- h. Date and Time Calibrated
- i. Configuration By: (name of person)
- j. Detailed configuration/parameter settings

C. Field Demonstrations

1. After installation, instrumentation equipment shall be checked, calibrated, and tested.
2. Equipment shall be field demonstrated to operate satisfactorily throughout the specified operating functions in the presence of the Owner and Engineer. Field demonstrations shall be performed after successful installation, calibration and testing of each drive.
3. The Contractor shall provide the necessary test equipment, and qualified test personnel to perform the field demonstrations as specified herein.
4. Each electric actuator shall be field demonstrated for operation, and the following parameters shall be recorded on a test certificate.
 - a. Current @ maximum torque setting.
 - b. Torque @ maximum torque setting.
 - c. Flash Test voltage
 - d. Actuator output speed or operating time.
5. In the event of a failure of the field demonstration, the Contractor shall perform the necessary corrections and re-demonstrate, at his own cost and expense, the equipment as directed by the Engineer.

D. All tests and demonstrations shall be subject to the Engineer's approval.

3.3 MANUFACTURER'S SERVICES

- A. The Contractor shall furnish the services of a competent factory service engineer representing the manufacturer who shall start and operate the equipment. The representative shall supervise the installation of all actuators. The representative

shall conduct testing to adequately show that the equipment has been properly installed and will function as herein specified.

B. The manufacturer shall furnish field services of a qualified service engineer for two working days, who shall perform the following:

1. Check the installed equipment for correctness of assembly and connections.
2. Adjust protective and control devices as required.
3. Assist the Engineer and the Owner in the Testing and start-up of the equipment which shall include checking of equipment for compliance with the specifications. The manufacturer, after shop and field testing shall submit to the Engineer ten copies of final test data.

3.4 OPERATOR TRAINING

A. On-Site Training and Startup Assistance

1. During the startup of the project the contractor shall provide a minimum of two days of classroom, "hands-on" training and startup assistance for plant operations' personnel simultaneously commencing on a date agreeable to the Owner, Engineer, and Contractor.

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SECTION 40 94 00

PROGRAMMABLE CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes general requirements for all Programmable Logic Controllers (PLC), power supplies, I/O racks, I/O cards, Operator Interface Terminals (OIT), control & communications networks, control panel wiring guidelines, and associated equipment as specified and as shown on the Contract Drawings.
 - 1. All PCS PLC system components shall be from the Allen-Bradley ControlLogix, or FlexLogix family of products as indicated on the Drawings and specified herein, no exceptions.
 - 2. All PLC hardware within a single PCS cabinet shall be of the same product family.
- B. The Contractor shall obtain the services of an Instrumentation and Controls (I&C) Subcontractor, who shall be responsible for the coordination, supply, fabrication and integration of the equipment specified herein. This subcontractor shall be referred to as the Control Systems Integrator (CSI).
 - 1. The CSI shall have total responsibility for the coordination, final design, fabrication, configuration, I/O check out and full loop checks, and the implementation of a complete and fully operational Process Control System (PCS) as specified herein, specified elsewhere, and as shown on the Contract Drawings.
 - 2. The CSI is ultimately responsible for providing a fully functioning system. Contract Drawings of PCS control panels and cabinets are only to be used as guidelines, not as detailed design. Detailed design is done by the CSI as specified herein and specified in referenced related Sections.
 - 3. The CSI shall configure, startup, and commission all instrumentation, instrumentation equipment, and components not supplied by major equipment Vendors as part of their scope.
 - 4. The CSI shall design, purchase, fabricate/assemble, factory checkout, ship, receive, configure, and checkout (full I/O loop checks) all PCS control cabinets/panels for the PLC CPUs, PLC I/O, OITs, and other PCS components as shown in the Contract Documents.
- C. The Electrical Contractor shall install, mount, wire, and terminate all electrical instrumentation connections to the CSI provided control panels as shown in the CSI's coordination drawings and panel drawings.

- D. As shown in the Contract Drawings, the PLC system architecture shall consist of the following elements as a minimum:
1. Multiple PLC (Programmable Logic Controller) shall be strategically located to minimize wiring and maximize operational flexibility and reliability. The PLCs shall be located within PCS cabinets.
 2. Many PCS cabinet shall have door-mounted OIT (Operator Interface Terminal), communicating directly with its associated PLC, providing operational real-time equipment status, analytical data, and process control through object-based graphical Operator screens. This will permit local and remote I/O (RIO) monitoring and operational control of the associated process area, regardless of the SCADA Ethernet network status.
 3. Each PCS cabinet has its own (internally mounted) UPS (Uninterruptible Power Source) system, capable of powering all PLC, I/O, OIT, and communications/networking equipment; all field instruments, analyzers, and transmitters; and all PLC analog and discrete inputs for at least 30-minutes during power outages. PLC discrete outputs, and utility power (interior light, utility receptacles) are exempt.
 4. All fiber communications strands of each cable shall be terminated in a proper fiber optic patch panel at each end, using "SC" style connectors.
 5. PLC peer-to-peer communications will be programmed for status/value sharing and software interlocks.
 6. Hardwired signals and Ethernet shall be used. No other communication or field bus protocols shall be used.
 7. PLC I/O (Input/Output) signals shall be hard-wired to terminal strips in the local PLC cabinets using conventional copper wire and cables, transmitting conventional electrical signals (4-20mADC, 24VDC, 120VAC, dry relay contacts, etc.).

1.3 RELATED SPECIFICATION SECTIONS

1. All Division 26 Electrical Sections
2. Division 40 "Instrumentation General"
3. Division 40 "Process Control System"
4. Division 40 "Control Systems Integrator"
5. "General Conditions"

1.4 COORDINATION REQUIREMENTS

- A. Enclosures shall be located, installed, and wired as shown in the Contract Drawings.
- B. Coordinate installation with General Contractor. General Contractor shall be responsible for process piping (air, water, etc.) to and away from equipment.
- C. Verify process connection(s), electrical connection(s), and ranges for both process and electrical.

- D. Materials of construction shall be suitable for the intended application and environment.
- E. Install, wire, and configure per the manufacturer's recommendations.

1.5 SUBMITTALS

- A. Provide submittals as required by the General Conditions, Division 1, and Division 40 Section "Instrumentation General".
- B. Preconstruction;
 - 1. Product Data: "Catalog cuts" and spec sheets marked to specifically indicate the equipment and materials proposed for this project. Indicate selections with arrows, and cross out irrelevant data. Label each data sheet with the tag ID assigned to the instrument.
 - 2. Shop Drawings: Electrical wiring diagrams/schematics, control panel and subpanel layout details (to scale), Bill of Materials, terminal block details, SCADA (communications networking) One-Line diagram(s).
 - 3. Manufacturer Instructions: Installation instructions.
- C. Closeout Submittals
 - 1. Operation and Maintenance Manuals: Installation instructions, Configuration and setup instructions, Quick start guides, User Manuals.
 - 2. Warranty Documentation: Start date, duration, conditions, manufacturer contact information, local vendor or support representative contact information.
 - 3. Software: Vendor, Manufacture, and Contractor supplied.

1.6 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer's Factory Qualifications: Manufacturing facilities shall have accreditation to ISO 9000:2000 or an equivalent quality management system acceptable to the Owner's Representative.
- B. Equipment not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with ANSI, IEEE, ISA, JIC, NEMA, and other applicable technical standards. The work shall have neat and finished appearance.
- C. All PCS cabinets and PCS control panels shall be UL 508A listed, with proper labeling and documentation.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Temporary storage of equipment shall be in clean dry indoor rooms with a temporary dehumidifier and electric heating to maintain the storeroom between 5 and 40 °C, with humidity less than 90%. Comply with manufacturer's additional written instructions for storing and periodic inspection and testing.
- B. Handle equipment in conformance with the manufacturer's written instructions.

1.8 WARRANTY

- A. Provide parts and labor warranty in accordance with the General Conditions.
- B. Provide an on-site parts and labor warranty for a minimum period of one year after Substantial Completion for all equipment. In cases where the manufacturer offers a longer warranty period, the longer warranty period shall apply as described by the manufacturer.
- C. All equipment that are not fully functional at the time of Substantial Completion shall have warranties extended to provide minimum one year coverage after making the instrument operational, unless otherwise approved by the Owner's Representative.

PART 2 - PRODUCTS

2.1 GENERAL

- A. ELECTROMAGNETIC INTERFERENCE
 - 1. Power conversion equipment, including computer power supplies and Uninterruptible Power Supplies (UPS), shall be fitted with EMI (electromagnetic interference), RFI (radio frequency interference), and telephone interference filters to limit interference effects on other equipment in the surrounding area, in accordance with IEEE standards and recommendations applicable to the equipment.
 - 2. Equipment may be powered from electrical sources that may include harmonic distortion, surges, sags, and other electrical noise under normal operating conditions. Equipment furnished under this Contract shall be installed with such accessories, surge protection, power line conditioners, UPS, or other means as may be required for it to function correctly in this noisy electrical environment.
- B. Equipment providing similar function shall be of the same manufacturer and, as much as possible, the same model/series for purposes of parts interchangeability.
 - 1. All PLC hardware within a single cabinet shall be of the same PLC family
- C. Equipment shall be new, of the latest design, original, and free from defects.
- D. All cables, software, mounting kits shall be included, compatible with the system.
- E. PLCs shall perform process control and monitoring functions and allow remote monitoring. General requirements include:
 - 1. Receive analog data (via 4-20mA hardwired I/O), convert to Engineering Units (EU), process for alarms and reasonability checks and store.
 - 2. Receive digital data (hardwired I/O), check for alarm and status change and store.
 - 3. Perform control calculations, including software PID control based on system parameters and real-time data and output properly conditioned control commands.
 - 4. Perform sequential control functions and timing functions
 - 5. Respond to operator requests for displays, control commands and data.

6. Communicate process data with Operator Interface Terminals (OIT) via Ethernet.

2.2 ACCESSORIES

- A. Equipment shall be provided with accessories recommended by the manufacturer for proper operation.
- B. Any devices, equipment, interfaces, hand-held devices, cables, connectors, necessary to configure, modify, analyze, and calibrate supplied equipment shall be provided with the equipment and be turned over to the Owner after successful commissioning.
- C. Where recommended by the manufacturer, power converters, reactors, or power supplies shall be provided integral with the instrument.

2.3 EQUIPMENT

- A. PLC Hardware
 1. For transparent and seamless peer-to-peer communications with the other system control panel PLC via Ethernet, all PLCs supplied on this project shall be from Allen-Bradley's Logix families (ControlLogix). New FlexLogix and Micrologix components are not allowed unless otherwise indicated. Network and protocol converter boxes and converter software for communications with Allen-Bradley Logix PLCs by alternate PLCs are not allowed.
 2. Each PLC installation shall have one USB port for local programming. All ControlLogix installations shall have a 10/100Base-T Ethernet interface card (rack mounted) for OIT/SCADA communications.
 3. Provide I/O and networking/communications cards & modules as required.
 4. Provide each PLC processor module with redundant power supplies.
 5. Processor requirements:
 - a. As indicated on the Drawings
 - b. Supports ladder logic programming;
 - c. Be sized to provide 50% spare memory after fully configured and programmed;
 6. I/O Networks:
 - a. Other than Ethernet for OIT/SCADA, and ControlNet for remote I/O, no other communication or field networks shall be used.
 - b. Shall not be loaded more than 60%.
 7. I/O general:
 - a. Instruments and devices shall be hardwired using conventional conductors and signals (4-20mA dc, 120Vac, dry contact closure, RTDs, etc.). Interposing relays shall be provided as required to convert discrete signals.
 8. Discrete I/O:
 - a. Discrete Input (DI) modules shall be 120Vac Individually Isolated.
 - b. Discrete Output (DO) modules shall be individually isolated dry relay-contact type (2A minimum at 120VAC contact rating).
 9. Analog I/O:
 - a. 2-wire loop powered instruments shall be powered from the same power source within the same PLC cabinet. Single-ended analog input cards can be used.

- b. 4-wire non-loop powered instruments require isolated analog inputs. Single-ended inputs shall not be used.
 - c. All 4-20 mAdc analog outputs shall be isolated from each other.
 - 10. Spare
 - a. 20% spare I/O points of each type, at each new location, shall be installed and pre-wired to terminal strips.
 - b. All spare I/O points shall be wired to terminal strips.
 - c. Size PLC I/O back planes as required. For all ControlLogix installations, provide a minimum of 20% spare/empty slots or shall be available at each location at the time of installation.
 - d. All empty slots shall have blank filler cards or protective covers.
 - 11. Manufacturer/Model:
 - a. All PCS PLC system components shall be from the Allen-Bradley ControlLogix family of products unless otherwise indicated.
- B. Operator Interface Terminals (OIT)
 - 1. Provide OITs as shown in the Contract Drawings
 - 2. Color touch screen of not less than 12 inches viewable
 - 3. OIT shall be industrial hardened with a NEMA 4 bezel.
 - 4. Ethernet/IP communications.
 - 5. Shall be Allen Bradley PanelView Plus, Magelis, or approved equal
- C. Firmware
 - 1. All PLC and OIT hardware, communication modules, I/O modules, and networking hardware containing “flashable” firmware shall be flashed with the latest and most compatible firmware version before startup and checkout.
- D. Software
 - 1. Provide one (1) retail package (box and manuals included) of the PLC manufacturer's most current “Professional Edition” PLC offline/online programming software for use in conjunction with the PLC equipment supplied (to become the property of the Owner). The software provided must be fully compatible with the firmware level of all PLC hardware supplied. Provide all communication cables necessary for a laptop computer to upload/download and modify/monitor the PLC program offline/online.
 - 2. Provide one (1) retail package (box and manuals included) of the OIT manufacturer's most current “Professional Edition” application development and transfer utility software for use in conjunction with the OIT equipment supplied (to become the property of the Owner). The software provided must be fully compatible with the firmware level of all OIT hardware supplied. Provide all communication cables necessary for a laptop computer to download the application to the OIT.
 - 3. General
 - a. All software licenses shall not expire and support shall be renewable.
 - b. All software provided shall be fully compatible with all the devices and equipment it will be connected to. Hardware firmware levels and versions shall also be fully compatible.
 - c. All software shall be provided in retail boxes with full documentation, manuals, media, and information cards.

- d. All software, licensing, and support shall be registered to the CSI until time of substantial startup completion. At this time, the CSI shall transfer registration and Ownership of all supplied software, licensing, and support to the Owner and provide written proof of transfer.
- 4. Accessories
 - a. Provide all necessary communication cables and miscellaneous hardware required by the software, to be turned over to Owner.
 - b. Any additional software or drivers required by the PLC and OIT software shall be provided at no additional cost to the Owner.
 - c. The CSI shall maintain, install, configure, and deliver all software updates, patches, and revisions issued prior to substantial completion.
 - d. The CSI shall pay up registration and technical support (in the Owner's name) with the software manufacturers for the entire duration of the project warranty period so that there's no lapse in software support or coverage for the Owner. Project warranty period starts from the day of Owner acceptance, not the completion of startup, or when the software was purchased.
- 5. The CSI shall also provide the Owner two (2) identical DVDs, each containing the same "fully-documented" CSI developed PCS software applications for all PCS/SCADA applications, PLCs, and OITs containing all program files (source code), cross references, data tables, document export files, initial setpoint/startup values, configurations, driver setups, applications, and all other files developed and used by the CSI during development, debug, and successful startup.

2.4 SPARE PARTS

- A. All spare parts shall be packaged in separate containers with the part name and number clearly marked.
 - 1. Package spare parts in wooden boxes, labeled with the manufacturer's name, address and telephone number; local representative's name, address and telephone number; name of equipment the parts are for and list of parts contained therein.
- B. All spare parts shall be included in the base bid.
- C. Provide the following spare parts, packaged in their original unopened boxes, for use by the Owner.
 - 1. 1 – processor (CPU) of each type supplied
 - 2. 1 – rack or backplane of each type supplied
 - 3. 1 – power supply of each type supplied
 - 4. 1 – communication interface card of each type supplied
 - 5. 3 – I/O modules of each ControlLogix type supplied
 - 6. 2 – I/O modules of each FlexLogix type supplied
 - 7. 25% spare fuses of each type used
- D. All equipment shall be provided with supplies as would be expected to last one (1) year: spare parts (bulbs, fuses, etc), and other apparatus necessary for continuous and accurate operation.

1. Spare parts shall include all parts normally provided by the manufacturer for systems of similar size, construction, and purpose.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with manufacturer's installation recommendations and requirements.
- B. Examine roughing-in of equipment to verify the following:
 1. Environmental conditions are within the limitations established by the manufacturer.
 2. Each utility pipe and conduit is in the correct location.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for installation, for example, all overhead work of other trades is complete.
- D. Verify that ground connections are in place and that installation of grounding described in Section "Grounding" is complete.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install equipment as shown on the Contract Drawings and in accordance with the manufacturer's installation instructions and recommendations.
- B. Erect equipment in neat and workmanlike manner; align, level and adjust for satisfactory operation. Install so that parts are easily accessible for inspection, operation, maintenance and repair. Equipment shall be mounted upright, vertical, at eye level, and in locations easily and safely accessible. Minor deviations from indicated arrangements may be made, but only after obtaining approval from the Owner's Representative.
- C. AC power, DC power/signal, and communication cables shall be installed in separate conduit systems, and shall be physically separated by a minimum of 12 inches.
- D. Electronic low-level signals (analog, discrete, and communications) shall be properly isolated, bundled and supported. These signals shall be routed and separated from AC power wiring.
- E. All "intrinsically safe" wires and cables shall be kept isolated and installed in separate wire channels and conduit systems from normal power and signal wires - by at least two inches of space. Label wire channels and conduits "Intrinsic Wiring".
- F. Grounding
 1. Equipment shall be solidly grounded with an equipment grounding conductor as specified in Section "Grounding" and as recommended by the manufacturer.

- Control panels and instruments shall be grounded at the power supply end using a ground wire pulled with the power wires.
2. All instruments and transmitters shall be grounded at the device's power source by the CSI using a ground wire pulled with the power wires. Metal cases of loop-powered instruments shall be grounded at the control panel powering the loop using a ground wire pulled with the twisted-shielded pair of wires. All transmitters and metal cases shall be grounded at the control panel with a ground wire. Grounding through conduit and fittings and to grounds other than that of the control panel are not acceptable.
 3. The shield in twisted-shielded pairs shall be grounded at the power supply end. Meaning, 4-wire transmitters = ground at transmitter end, 3-wire transmitters = ground at power source end, 2-wire transmitters = ground at loop power source end.
- G. Furnish and install all mounting stands, supports structures, brackets and accessories as required or detailed for the installation of the equipment furnished. Unless otherwise specified or required, supports shall be aluminum or stainless steel. All mounting hardware shall be stainless steel. Equipment mounted on walls in contact with soil or water shall be mounted offset from the wall a minimum of ¼-inch.
- H. Cutting and drilling of existing panels for new equipment as shown, specified, or required, shall include repair and touch up painting of panel after installation.

3.3 FACTORY QUALITY CONTROL

- A. Prior to the fabrication of any control panel or enclosure, the CSI shall submit layout drawings to the Owner and Engineer for review and approval. Layout drawings shall include electrical wiring diagrams/schematics, control panel and subpanel layout details (to scale), Bill of Materials, terminal block details, communications networking, One-Line diagram(s), interconnection wiring diagrams, mounting and installation diagrams, etc.
- B. All control panels shall be fully tested at the factory, checking for proper voltages, proper fuse sizes, good wire terminations, proper wiring and routing, etc. Each and every wire shown on the CSI created wiring diagrams shall be rung out and verified for proper routing, voltage, and terminations. All components within each circuit shall be verified for proper settings and adjustments. The testing technician shall highlight (on paper) each circuit when it has been fully tested, verified, and has passed QA/QC. All circuits shall be highlighted (fully tested and verified) before the panel shall be shipped. Deliver these testing documents (highlighted wiring diagrams) with the panel and provide the Engineer with three (3) color copies of these testing documents via mail.
- C. All PLC I/O points shall be verified for proper monitoring and control action from within the PLC I/O tables.
- D. Control panels arriving onsite without Owner and Engineer reviewed and approved QA/QC testing documents, fully executed, will not be received.

3.4 FIELD QUALITY CONTROL

- A. The Electrical Contractor and the CSI shall work together to systematically verify proper installation and terminations of all field wires, and proper settings/adjustments of all devices and components contained within each circuit. The CSI shall perform full loop checks on all PLC I/O points (analog, discrete, networked, etc.), of both used and spare I/O, from within the PLC I/O and memory tables.
- B. The CSI shall highlight (on paper) each field circuit (as shown in the field wiring diagrams provided by the CSI) when it has been fully tested, verified, and has passed QA/QC. All circuits shall be highlighted (fully tested and verified) before the panel shall be accepted. Provide these fully executed field testing documents (highlighted wiring diagrams), plus three (3) color copies to the Engineer for review and approval.
- C. Perform tests in accordance with the following standards:
 - 1. NETA ATS.
- D. Prepare for Acceptance Tests as follows:
 - 1. After installing equipment but before power supply is energized, verify that grounding system is completed.
 - 2. Verify that equipment is installed and connected according to the Contract Documents.
 - 3. Verify that electrical wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing.
 - 4. Verify that field-installed power and control wiring complies with the Electrical Specification requirements.
 - 5. Verify that equipment is ready for pre-commissioning checks in accordance with manufacturer's written instructions.
- E. Acceptance Tests: After installing equipment and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements as follows:
 - 1. Perform visual and mechanical inspection and electrical tests according to NETA ATS, Section 7, as it applies to all installed systems and devices. Certify compliance with the following test parameters:
 - a. Circuit Breakers: Perform tests and inspections stated in NETA ATS, Section 7.6.
 - b. Protective Relays: Perform tests and inspections stated in NETA ATS, Section 7.9.
 - c. Instrument Transformers: Perform tests and inspections stated in NETA ATS, Section 7.10.
 - d. Metering and Instrumentation: Perform tests and inspections stated in NETA ATS, Section 7.11.
 - e. Ground-Fault Systems: Perform tests and inspections stated in NETA ATS, Section 7.14.
 - f. Surge Arresters: Perform tests and inspections stated in NETA ATS, Section 7.19.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 PROGRAMMING

- A. The CSI shall be responsible for the complete and satisfactory programming of all items under their source of supply.
- B. All control logic shall reside in the PLC, not in the Operator Interface Terminals (OIT) or SCADA system.
- C. All scaling of analog values and alarm/action setpoints to Engineering Units (EU) shall be done in the PLC, not in the Operator Interface Terminals (OIT).
- D. PLC control logic shall be developed in accordance with Division 40 Section "Process Control System".
- E. PLCs shall be programmed substantially in RLL (Relay Ladder Logic) language. Programming shall be fully documented with descriptive names and explicit line by line code comments.

3.6 OPERATION & MAINTENANCE MANUALS

- A. The CSI shall prepare four (4) Operation & Maintenance Manuals as specified in the General Specifications, consisting of equipment manufacturers' O&M manuals, user manuals, installation instructions, configuration instructions, etc., and specified hereinafter. Each shall include:
 - 1. Index and tabbed section dividers.
 - 2. Reviewed submittals.
 - 3. Wiring diagrams.
 - 4. Field adjustable settings (e.g. setpoints, ranges, spans current alarm trips)
 - 5. Manufacturer's instructions on care and operation of equipment.
 - 6. Warranty certificates.
 - 7. Spare parts list.
 - 8. Complete typewritten operating instructions, covering all systems descriptions and operation, emergency operating instructions and precautions.
 - 9. Name, address and telephone number of supplier and representative of manufacturer for each item of equipment in Contract.
- B. Bind above items (all unused, clean, and legible) in three ring binders and submit to the Owner's Representative for review and approval. Provide all required copies of reviewed and approved portfolios before request for final acceptance.

3.7 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment.
 - 1. See Division 01 "Demonstration and Training"
 - 2. Train Owner's maintenance personnel for a minimum of 8 hours on procedures and schedules for energizing and de-energizing, troubleshooting, servicing, and maintaining equipment and schedules.

3. Review data in Operation and Maintenance manuals with plant staff.
4. Schedule training with Owner, with at least 14 days advance notice.

3.8 FOLLOW-UP SERVICE

- A. Monitoring and Adjusting: After Substantial Completion, but not more than twelve months after Final Acceptance, perform the following monitoring and adjusting tasks:
 1. Replace failed and defective equipment (under warranty).
 2. Retest and adjust as necessary.

* * * * *

SECTION 40 95 00

PROCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

A. General

1. Provide a complete, integrated, and fully functional Process Control System (PCS), including PCS workstations, PCS cabinets, programmable logic controllers (PLCs), communications networks, field instruments, software, programming, and integration of process control subsystems and components provided under other Sections of the Specification.
2. The Process Control System descriptions outline minimum system control and monitoring functionality to be used as the basis for PLC programming, OIT graphics and programming.
3. All source code, OIT screens, database, alarming, tagging, etc. shall maintain project consistency. Graphics displays and text shall share a common look; display titles should appear in the same location, background color schemes shall be the same, font size and color should be the same, and dynamic linking should be consistent.
4. The CSI shall be aware that upgrades to existing plant systems may require careful consideration, during construction to avoid shutdowns and provide adequate construction sequencing.
5. The system shall include equipment hardware and software packages as shown and specified.

B. Description

1. The existing Remote I/O network shall be modified to include distributed controllers, strategically placed in areas of the plant, and reconfiguration of the existing ControlNet network.
2. The existing network shall be modified as shown or indicated in the Contract Drawings.
 - a. Remove existing loop controllers from the existing cabinets and integrate into PLC controllers, near their respective areas of control/monitoring, and make available at OIT and SCADA.
 - b. Modify existing ControlNet network, as shown on the Contract Drawings, to tie-in RIO nodes to new controllers. Provide network connectors, modules, taps, etc. as necessary.
 - c. Create a new self-healing fiber-optic ring to network new process controllers. Provide fiber-optic patch panels, Ethernet switches, media converters, connectors and accessories, as necessary.

3. Upgrade existing controllers with new ControlLogix controllers as specified.
4. Provide new process control system cabinets, complete with controllers, I/O, OIT, UPS, patch panels, Ethernet switches, etc., in each process areas, as shown on the Contract Drawings, to provide local control and monitoring capabilities.
5. Develop new graphical interface to allow local control and monitoring of existing equipment
6. Upgrade existing SCADA to FactoryTalk SE and develop new process graphic screens for remote monitoring of the process equipment.
7. Provide Floe totalizing screen for all flow meters. Flows are to be totalized every day at midnight.
8. Provide a minimum of five Reports. Reports to be identified during construction.
9. The paperless recorder in the chlorine bldg. lab will be replaced with SCADA based historian software.

1.3 RELATED WORK

- A. Division 26 Section "Data Highway Cables" for PCS serial link, fiber optic cables, and computer cables.
- B. Division 40 Section "Control Systems Integrator" for PCS integration and coordination meeting requirements.
- C. Division 40 Section "Instrumentation General" for PCS monitoring field instruments. Additional process control and monitoring equipment is specified in other Divisions.
- D. Division 40 Section "Programmable Controllers" for PCS PLC hardware, software, I/O and communications requirements.

1.4 DEFINITIONS

- A. In addition to the definitions in Division 40 Section "Instrumentation - General", the following definitions apply to this Section:
 1. AI: Analog Input
 2. AO: Analog Output
 3. CMMS: Computer Maintenance Management Software, see also ERP
 4. CV: Control Valve (Open / Close)
 5. DI: Discrete Input
 6. DO: Discrete Output
 7. ERP: Enterprise Resource Planning, see also CMMS
 8. FCV: Flow Control Valve (Positioner)
 9. HMI: Human Machine Interface, see SCADA
 10. LAN: Local Area Network
 11. L-O-R Local-Off-Remote selector switch
 12. NC: Normally Closed
 13. NO: Normally Open
 14. OIT: Operator Interface Terminal with process monitoring and control graphics software, and touch-screen color monitor

15. PCS HMI: PCS Workstations and PCS OITs
16. PCS Workstation: PCS computer with operating system, process monitoring and control graphics software, color monitor, keyboard, and mouse.
17. PCS: Process Control System
18. PS: Pump Station
19. SCADA: Supervisory Control And Data Acquisition
20. TCP/IP: Transfer Control Protocol / Internet Protocol
21. VFC: Variable Frequency Controller
22. VFD: Variable Frequency Drive
23. WAN: Wide Area Network

1.5 SUMMARY

- A. This Section describes requirements for the following:
 1. PCS computers and software
 2. PCS and Administrative networking
 3. PCS programming, testing, startup, commissioning, and training.
- B. The PCS shall provide monitoring and control of wastewater treatment processes as a unified system, with a consistent look and feel.
- C. The “Control Systems Integrator” (CSI) shall design, furnish, program/configure, and supervise the installation of the entire PCS. Following installation, the CSI shall provide experienced, competent, personnel for start-up, program de-bugging, commissioning, and training services.
- D. This Section includes Process Control Descriptions for the wastewater treatment process. The process control system descriptions outline the system control and monitoring functionality to be used as the basis for PLC programming, PCS graphics, and PCS software selection and programming.
 1. The Process Control Descriptions shall be used in conjunction with the Drawings and Specification to develop programming that meets the requirements described in each process-related Section of the Specification.

1.6 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 1. ANSI - American National Standards Institute
 2. ASME - The American Society of Mechanical Engineers
 3. ASTM - The American Society for Testing Materials
 4. NEMA - National Electric Manufacturers Association
 5. UL - Underwriters Laboratories, Inc.
 6. ISA - Instrument Society of America
 7. IEEE - Institute of Electrical and Electronic Engineers
 8. NEC - National Electrical Code

1.7 GENERAL DESCRIPTION OF SYSTEM

- A. The Process Control System Ethernet network communications will be physically separated from the plant's administrative and security networking except through a single firewall at the Lab as shown on the drawings.
 - 1. Process Control System Ethernet Network shall be indicated by use of orange cabling whenever possible.
 - 2. The firewall is to be configured as tightly as possible to limit MAC addresses and unauthorized network traffic.
- B. At the top of the PCS hierarchy, the redundant SCADA and Historian servers will be virtualized on an isolated network at the Administration Building within the existing server rack.
- C. The PCS network shall communicate over a fiber-optic data highway configured as a self healing bi-directional Ethernet ring.
 - 1. Local, within a structure, communications may be copper based Ethernet
 - 2. ControlNet connected Remote Inputs and Outputs will remain and be distributed as shown. No other field busses or telemetry is to be used.
- D. Remote visibility of select information will be made available to off-site viewing through hardwired signals to the existing chart recorder which will have an administrative network connection.
- E. The PCS workstations and PCS cabinets shall each be equipped with an Uninterruptible Power Supply (UPS) sized to maintain 120VAC power supply to the equipment for a time. Utility lights, utility receptacles, and motors are excluded. All computer equipment shall operate on 120VAC, 60 Hz power.
- F. At the middle of the PCS hierarchy, Remote automation locations, located in major process areas, consisting of a PCS cabinet with PLC and I/O racks with DI modules, DO modules, AO modules, and AI modules as required. PCS cabinets shall be internally wired with terminal blocks for field wiring connections to process equipment and field instruments, as shown on the Drawings and specified.
 - 1. Remote automation locations will be capable of running autonomously as a standalone system in the absence of a network connection but will generally operate with network connectivity to the rest of the PCS.
 - 2. PCS cabinets with touch-screen Operator Interface terminals (OITs), as shown on the drawings, will have with process graphic display for localized control of the process as well as a plant overview and alarming
 - a. OIT's will include local capture and historical trending of all analog values from that process area. The values are buffered for local review and may be saved off for passage to the SCADA.
 - b. To limit network traffic the PCS OIT's shall be nodes on the control network and configured to communicate exclusively to the local PLC or receive pushed information from other PLC's. OIT's shall not poll the system at large for information. PCS OIT's shall be able to direct the local plant process to initiate control algorithms programmed into the process controllers.

- c. A general plant overview screen including major process flows and equipment data will be visible at each OIT. All process equipment and devices controlled out of the local PLC or it's remote I/O network shall be provided with an OIT interface. Additionally, limited control of a few remote devices and such information as would be required for operational decisions of the local process equipment will be made available at the local OIT's as coordinated through the CSI coordination meetings.
- G. At the "field" end of the PCS hierarchy, PCS Cabinet field wiring interfaces with process equipment in each process area shall be as follows:
 - 1. DI: Remote NO and NC dry contact inputs powered by a mixture of 24 VDC or 120Vac from each PCS cabinet. Barrier relays will be used as required to convert the voltages where required.
 - 2. DO: DO points will feed plug-in relays with 10 amp Form C contacts at 28 VDC or 120 VAC 80% Power Factor remote control circuits
 - 3. AI: isolated 4-20 mA DC input current loop
 - 4. AO: 4-20 mA DC output current loop powered by the PCS cabinet
- H. Field instruments, process equipment control panels, valve actuators, motor control centers, individual motor controllers, and individual process control discrete and analog devices transmit information and receive commands from the PCS cabinets as shown on the Drawings.

1.8 SUBMITTALS

- A. Submittals shall be as required by the General Conditions, Division 1, and Division 40 Section "Instrumentation General".
- B. The CSI shall submit to the Engineer and solicit comments from the Owner or duly designated representatives for the following items at 20%, 90%, and 100% completion milestones:
 - 1. PCS HMI and OIT screens (color hardcopy printouts)
 - 2. PCS HMI AND OIT tag databases (tag name, description, ranges, Engineering Units, state descriptions, alarming info, etc.) and configuration information (hardcopy printouts)
 - 3. PCS automatic reports (hardcopy printouts).
 - 4. The 20%, 90%, and 100% completion submittals shall be provided in hardcopy paper format and an agreeable electronic format for review.
- C. Operations and Maintenance manuals. Separate volumes shall be submitted for hardware and for system software. The System Software O&M's shall additionally contain:
 - 1. I/O Lists
 - 2. Final Process Control Description for each Loop
 - 3. Copies of the Graphics displays
 - 4. Copies of Report Templates
 - 5. Electronic copies of all programs and graphics in their native formats with all rights.
 - 6. Ethernet IP address listing describing all equipment on the network.

1.9 QUALITY ASSURANCE

- A. All computer equipment and software furnished under this project shall be furnished by manufacturers who meet the quality, workmanship, and experience requirements as specified in the General Specifications section of this Contract.
 - 1. All computer equipment furnished under this project shall be new, of the latest design, original, and shall have a new warranty.
 - 2. All computer equipment furnished under this project shall operate on the same and the most current and most stable Microsoft Windows “Professional” Operating System available at the time of purchase. All Service Packs & updates shall be pre-installed and configured by the CSI. All computer equipment & software shall be licensed and registered with the original manufacturer or warrantee company in the name of the Owner.
 - 3. The CSI shall provide all backup documentation certifying hardware compliance with this specification as required by the Engineer. Any equipment provided by the CSI that exceeds the requirements of this specification shall be provided at no addition cost.

1.10 HARDWARE MANUALS

- A. All equipment, devices, and materials furnished by the CSI, as a part of the work of this Contract, shall be accompanied by all information, instructions, warranty information, paperwork, and data necessary for the proper and complete care, operation, maintenance and repair by the Owner. Hardware manuals shall be furnished in accordance with General Specifications.

1.11 OPERATION & MAINTENANCE MANUALS

- A. In addition to the Hardware Manuals, the CSI shall generate and assemble “Operation & Maintenance” manuals containing the following information and features as a minimum:
 - 1. Table of Contents
 - 2. Theory of Operation, Process Control Description
 - 3. Design and Operating Specifications, Criteria
 - 4. Recommended installation arrangement, locations, wiring, criteria, and procedures
 - 5. Normal and emergency operating instructions, procedures and sequences for each possible mode of operation
 - 6. Normal operating parameters, setpoints, configurations
 - 7. Troubleshooting procedures
 - 8. Preventative or routine maintenance requirements or recommendations
 - 9. Parts layout, identification, and assembly diagrams, including exploded views with parts referenced by name and/or number
 - 10. Parts lists of each assembly and subassembly showing part name, number, size, composition and quantity required, down to discrete components
 - 11. Recommended spare parts stocking lists
 - 12. Names, addresses and telephone numbers of factory authorized or recommended service representatives and parts suppliers
 - 13. Major overhaul and repair procedures including diagrams, measurements,

- clearances, adjustment settings, and alignment procedures
 14. Approved Instrument Loop Diagrams prepared in conformance with ISA-5.4-1991 with 5.2 Minimum Content Requirements and 5.3 Optional Content Information showing all PCS components and wiring, as well as software addresses and communications links
 15. Any other information necessary or recommended for the complete and proper operation, maintenance and repair of the equipment by the Owner's personnel
 16. Where an item of equipment includes components or subassemblies manufactured by other than the equipment manufacturer, all pertinent information for the subassemblies shall be included in the equipment manual prepared and compiled by the equipment manufacturer
 17. Software/Hardware operation & configuration information including all information required to reinstall the system as it is currently operating in the event the system fails
- B. The Operation & Maintenance Manuals shall bound in 3-ring binders, utilizing tabbed section dividers, and shall be submitted to the Engineer for review and acceptance in accordance with the Supplementary Conditions and Division 01.

PART 2 - PRODUCTS

2.1 HARDWARE

- A. Specific items to be purchased shall be discussed with the Owner at CSI progress meetings and approved prior to any Allowance item purchase. The general intent is to provide the Owner with the latest technology at the time of purchase. The following is a general level of performance to meet these expectations at the time of writing. Purchases are not intended to be made until required for implementation or 90 days prior to expected substantial completion. Hardware and Software purchased under this section are to be coordinated, installed, and configured for operation by the CSI at no additional cost to the Owner as described for Allowance Items.
- B. SCADA Workstation (Qty-1)
1. High-end Workstation platform, PC based
 2. Microsoft Windows Operating System (OS)
 3. Dual Intel processors (AMD not acceptable)
 4. 1TB SATA hard drive
 5. 16GB RAM
 6. DVD/CD+-RW SATA drive
 7. Network Adapter
 8. Purchase three (3) year 24/7 onsite repair warranty for labor and parts on all computer equipment from the manufacturer.
 9. Computer system shall simultaneously support three flat screen color displays and be provided with all interconnecting cables, keyboard, and optical 2-button wheel mouse w/ pad.
 - a. 21" Monitor (Qty – 3)
 10. Peripherals and Accessories
 - a. One-year maintenance and service contract on accessories.
 - b. Licensed Software at each Workstation or Server unless otherwise indicated

- 1) Latest Microsoft Office with MS Excel®, Word®, Powerpoint®, and Access®, and Internet Explorer applications
 - 2) Anti-virus and anti-spyware software with firewall.
11. Hardware shall be manufactured by Dell (preferred), HP, IBM, or approved equal.
- C. Uninterruptible Power Supply (Qty. 1)
1. Provide one UPS for each PCS Workstation or Server.
 2. UPS shall operate on 120VAC, 60Hz power,
 3. Minimum size: 2000 VA.
 4. UPS shall be true “on-line”, line-interactive, double-inverting units, with true sine-wave output.
 5. Acceptable manufacturers:
 - a. Liebert
 - b. APC
 - c. Powerware
 - d. Or approved equal
- D. Network Protection Firewall
1. Provide a Cisco ASA5505 / Security Plus firewall with license for at least 10 concurrent users or approved equal.
 2. At the discretion of the CSI and with the approval of the Engineer, a wireless access solution may be implemented during the programming startup and commissioning of the plant to facilitate remote access for the PCS programmer and is to be disconnected upon substantial completion.
- E. Miscellaneous Networking Hardware: The CSI shall supply and install all necessary networking hardware (cables, tees, taps, terminators, drop cables, connectors, etc.) required for a fully functioning system.

2.2 SOFTWARE

- A. The CSI shall provide all the necessary development software to program, debug and maintain the PCS System which at minimum shall include the following:
1. SCADA – (Qty. 2-redundant, 150% Tags) Rockwell Automation FactoryTalk View SE Server, or approved equal
 2. SCADA – (Qty. 1, 150% Tags) Rockwell Automation FactoryTalk View SE Client, or approved equal
 3. Historian – (3 seats, 1000 Tags) Rockwell Automation FactoryTalk Historian: The Historian software shall be ODBC compliant, SQL compatible, completely compatible with the SCADA HMI software, and manufactured by the provided SCADA HMI software’s manufacturer. The SCADA HMI and the Historian software shall be designed and built to work together seamlessly. The Historian software shall collect, store, retrieve, and manipulate large quantities of process related data over many years of continuous operation.
 4. Reporting – (3 seats) Rockwell Automation FactoryTalk VantagePoint, or approved equal
 5. ControlNet Network Configuration – (1 seat) Rockwell RSLynx for ControlNet or approved equal.

6. Web Server application – FactoryTalk ViewPoint Server (Qty. 1 to support a minimum of 5 concurrent client connections) or approved equal.
7. Network Visibility – (1 seat) Provide one retail copy (box and manuals included) of an Ethernet Visibility and Diagnostic software package. Software shall be licensed to support 50 nodes. Install, setup, and test software configuration on computer to be determined. Network diagnostic software shall be Hirschmann HiVision, Schneider Electric ConneXview, or approved equal.

B. Installation

1. Install and test software on Computers to be determined any programming software packages specified and supplied under Division 40 Section "Programmable Controllers". The CSI shall configure the software and test it online.
2. Install all necessary drivers and software for any interface cards provided. The CSI shall configure the drivers/software, test the provided cables-connectors-adapters, and verify proper operation and functionality of the interface cards.

2.3 SYSTEM BACKUP

- A. Upon substantial acceptance of the project, provide images of the Server Computers hard drives.
1. Provide the latest version of Norton Ghost, Power Quest Drive Image, or approved equal.
 2. Provide 2 external Hard Disk Drives (1TB minimum)
 3. Both the imaging software used to create the image and the image itself will be turned over to the Owner.
- B. After initial start-up and field-testing have been successfully completed and prior to substantial completion of this Project, the CSI shall change the registration of all software provided to the Owner and submit written confirmation of having done so. All licenses, keys, licensing documentation, media, manuals, packaging, and cables provided shall be turned over to the Owner on completion of startup. In addition, the CSI shall provide the Owner 2 identical DVD-ROM sets, each containing the same "fully-documented" PCS HMI/OIT and related application(s) and PLC program files (source code), cross references, data tables, tag databases, document export files, initial setpoint/startup values, and all other files used by the CSI for application development.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All equipment shall be installed as shown, specified, directed, and recommended by the manufacturer.
- B. All equipment shall be solidly grounded with a ground conductor as specified in Division 16 Section "Grounding and Bonding" and as recommended by the manufacturer.
- C. Temporary storage of all instrumentation equipment shall be in a humidity-controlled environment heated to a minimum of 55°F, maximum of 85°F and in accordance with the

General Specifications of the Contract Documents.

3.2 PROGRAMMING

- A. The CSI is responsible for the application development, configuration, testing, startup, de-bugging, commissioning, and training of the entire PCS, including but not limited to:
 - 1. PLC programming
 - 2. OIT process graphic and trending screens
 - 3. HMI programming and process graphic screens
 - 4. HMI historical trending screens
 - 5. HMI automatic reports
 - 6. Ethernet Visibility and Diagnostic network setup
 - 7. Firewall configuration
- B. The entire PCS application development encompasses field instruments and all control systems provided by the major equipment suppliers. Process graphics screens, trending screens, database points, alarm points, and reports shall be developed for all of these systems.
- C. The PLC programming of control logic shall be developed by applying the “General Description of Operation” and “Process Control Description of Operation” contained herein, the Piping & Instrumentation Diagrams, and the Process Descriptions contained in each process equipment Section of the Specification.
- D. PLC programming shall be substantially done in ladder logic. Programming shall be fully documented with descriptive names, tag numbers, and explicit line by line code comments.
- E. The PCS shall be “Menu” driven. All operator functions shall be selected from a Master menu or submenu, including system configurations.
- F. The PCS shall monitor and control analog and discrete points in real-time. Each point in the system shall be scanned within 2 seconds. Alarm functions shall include alarming on high or low limit exceeded for analog and change of state for discrete points. Alarms shall be annunciated within 2 seconds of their occurrence.
- G. The PCS shall monitor, alarm, and log PLC CPU “Battery-Low”, “Major Fault”, and “Minor Fault” conditions from all PLCs, including PLCs supplied by other vendors.
- H. The PCS shall monitor, alarm, and log control panel power loss, UPS faults, and PLC system and card faults at the PCS Cabinets.
- I. The PCS shall include the following general features:
 - 1. Receive, store, and display data from the PLCs as digital and dynamic graphics. Update digital data 500 ms from change of state. Update analog data within 500 ms from exceeding the exception dead-band. Dynamic data fields shall be updated within 500ms.

2. Receive and store manually entered data;
3. Provide real-time and historical data for generation of reports;
4. Report change of state within 1 second;
5. Record change of state on designated points (alarms, events, run schedules) and date and time stamp;
6. Identify status change in up to eight-character word or selected graphical representation by color change, brightness, or flashing;
7. Ability to record time interval between status changes (elapsed time).
8. Provide an information operating system from which to generate reports and logs. Record alarms and events on the hard drive. Output report, logs, alarms & events to external printers.
9. Provide alarm notification.
10. Provide a multi-level security access code system for access to operator functions and control program changes.
11. Process request for changes to control status, setpoints, tuning parameters, control strategy modifications, and related process control monitoring.
12. Process control requests, such as start/stop, open/close, setpoint changes, and control strategy auto/manual status changes. The response from when the request is made at the OIT to when it is executed at the PLC shall have a maximum response time of 2 seconds.

J. Graphics displays & editor

1. Graphic displays shall be based on the Piping & Instrumentation Diagrams shown on the Drawings, with the enhancements described below. As a minimum, the CSI shall develop one PCS screen for each Piping & Instrumentation Diagram drawing in the Contract documents.
 - a. Provide cross references to the P&ID Drawing numbers on the process links.
2. Piping shall be shown with two lines, color coded to generally match the AWWA process fluid designated colors, and with flow direction arrows inside the two-line piping. Flow direction arrows shall be menu-selectable as static or dynamic (flashing) as a general option.
3. Symbols for pumps, valves, and instrumentation shall be developed using the manufacturer's standard symbol library wherever possible. Customized symbols shall be provided in cases where the standard symbols do not make the distinctions between process equipment to the same level of detail as the Piping & Instrumentation Diagrams.
4. Equipment that is running/open to flow shall be monitored with GREEN color, and equipment that is off/closed to flow shall be RED color.
5. All graphic displays shall share a common "look and feel". Graphic displays titles should all appear in the same location, background color schemes, font size and color should be the same, and dynamic linking should be consistent. Each graphic screen shall have three regions; Title Bar, Main Graphic Area and Navigational Area.
6. Points in alarm will be displayed flashing until acknowledged and displayed with an alarm color until the point returns to normal.
7. Analog values with bar charts shall vary in proportion with the current analog value.
8. Dynamic values shall be updated at least once every 2 seconds.
9. Multiple-level password protection shall be provided for each screen and all data

- entry. The Owner will determine user names, passwords, and security level.
- 10. Screen areas may be tied to other displays, allowing displays to be linked.
- 11. An alarm window of current alarms shall be placed at the top of the screen.
- 12. A cursor shall highlight (mouse-over) the element selected on the display for data entry, allowing the operator to select any dynamic point on the screen through the cursor control keys.
- 13. The screen shall provide real-time digital display of all measured process variables associated with that portion of the process represented on the screen.
- 14. Tank levels shall be graphically and digitally displayed, both in percent of total volume, and volume remaining in gallons. Tank shape shall be approximately the same as the actual tank.

K. Process Graphics Screens

- 1. A general plant overview screen including major process flows and equipment data will be visible at each OIT and through the SCADA. Major process equipment and flows shall be displayed.
- 2. SCADA Screens
 - a. Assume 1 process graphic screen will be required for each P&ID Drawing in the Contract plus an additional 50%.
 - b. Plant Overview Screen: displaying all current flows, totalizers, and resets.
 - c. Equipment Status Screen: display current running and fault status of all monitored equipment in list form. May be combined with the runtime historical log.
 - d. PCS and communications status screen, include PLC system alarms, PLC module alarms, power alarms, and Ethernet alarms.
- 3. OIT Screens
 - a. Generally intended to mimic the SCADA interface of the local process equipment.
 - b. Include summary type information generated within the PLC for SCADA at the respective local process areas.
 - c. Include trending of all local analogs within each process area.

L. Alarm Summary Display Screens

- 1. Two "Alarm Summary" screens shall be developed for the Operators to view quickly during emergency situations.
- 2. Each "Alarm Summary" screen shall be accessible quickly via the Main Menu screen and its own-programmed global "hot key".
- 3. This alarm summary display must show a list of active alarms in the system. As new alarms are detected, entries are made to the display list. As the alarm conditions clear, the entries are removed from the list.
- 4. In addition to being able to configure the placement of the information (tag name, current value, descriptor, time of alarm, and alarm status)
- 5. Alarms can be acknowledged from the alarm summary display either individually (by clicking on an alarm acknowledgment field) or for all alarms in the queue.
- 6. The alarm summary display must provide sorting and filtering capabilities. The user shall be able to filter on alarm area(s), alarm status and alarm priority. The user must be able to sort on time, tag, alarm area, alarm priority and alarm status. The user must be able to display field or fields about the alarm block in a column format and do complex filtering.

7. Alarms should flash when first displayed at the HMI and an audible alarm should send, with short pulses and a pause for the alarm priority (as available).

M. Database Editor

1. The database editor shall consist of a fill-in-the-blanks full screen editor. It shall allow selection of polling and alarming options for each of the data points. A point shall be defined as analog, discrete, PID controller, or computed point located in the programmable logic controller. Changes in the database shall be implemented without interrupting the current data collection operation. A point shall contain the following fields at a minimum:
 - a. Point acronym
 - b. Point description
 - c. Point type (analog, discrete, controller, pulse, computed, etc)
 - d. PLC address
 - e. On-line/Off-line (active/inactive)
 - f. High limit alarm value (analog)
 - g. Low limit alarm value (analog)
 - h. Alarm condition (digital)
2. Tag names and descriptions shall be developed using loop numbers and tagging information from the Piping & Instrumentation Diagrams on the Drawings.

N. Report Generator

1. Usable on-line without disturbing process.
2. Access I/O points, access on line historical data, and calculations through their point tag.
3. The CSI shall create the following reports, as specified below.
 - a. Daily Summary Report. Summarize selected operations data from previous day. Print on demand.
 - b. Daily Flow Report: Summarize flow totals, maximum, minimum, average values. Print on demand.
 - c. Run Hours: Totalize pump daily run times and to-date totals, for each device for both Hand and Auto operation. The Total Runtime shall be resettable by entering a password/access code. Print on Demand
 - d. As selected by Owner or Engineer at time of construction. Print on Demand.
 - e. As selected by Owner or Engineer at time of construction. Print on Demand.

3.3 GENERAL DESCRIPTION OF OPERATION

A. PCS Control Modes:

1. Process motor controllers, control panels, control valves, and other controlled devices shall have the following control modes available for selection at the PCS Workstations and OITs:
 - a. PCS AUTO: Automatic Control from the PCS. The PCS transmits requests to the PLCs in the PCS cabinets to execute pre-programmed PLC-based control algorithms for START - STOP and setpoint commands to each controlled device. This mode requires that the

LOCAL-OFF-REMOTE selector switch at the controlled device is in REMOTE control position. Green “PCS Auto” indicator will appear next to the device shown on the PCS HMI process graphics screens. Automatic starting and stopping, process-based level, flow, and pressure setpoint controllers, and automatic fail-over controls are enabled.

- b. PCS MANUAL: Manual Control from the PCS via the HMI is required for all devices as I/O allows unless otherwise directed. This mode of operation shall permit start/stop, open/close, and adjust setpoint control of the device manually through the PCS. The device will remain in manual control mode and operate as requested by the Operator until it is changed back to automatic (PCS AUTO) mode at an HMI. This mode requires that the LOCAL-OFF-REMOTE selector switch at the controlled device is in REMOTE control position. However, in the absence of a LOCAL-OFF-REMOTE selector switch the system shall assume that control is available and rely on the disagreement alarm to provide feedback. Green “PCS Manual” indicator will appear next to the device shown on the PCS HMI process graphics screens.
- c. AUTO FAILOVER: When a controlled process device or instrument fails during normal operation, and the PCS is in PCS AUTO mode for that controlled process device, the failed unit shall be replaced by a redundant or dedicated standby available unit unless manually operated isolation valves effectively prevent automatic failover operation commands from the PCS from working.
- d. PCS LOCKOUT: When a devices Staggered Restart priority level is set to “Lockout” the PCS shall not be permitted to operate the device.

B. LOCAL-OFF-REMOTE Control Modes (at controlled devices in the field):

- 1. LOCAL: Manually controlled by the Plant Operator. Switching the controlled device LOCAL-OFF-REMOTE selector switch to the “LOCAL” position will remove the device from PCS control and enable full local control by the Operator at the controlled device. All mechanical equipment protection devices are still connected to the controlled device. Tank level controls and valve position interlocks routed through the PCS PLCs are not enabled in this mode, which is designed primarily for maintenance and troubleshooting purposes. Amber “LOCAL” text will appear on the PCS HMI process graphics screens when field-mounted L-O-R switches not in the “REMOTE” position.
- 2. OFF: Local control circuit and pushbuttons are de-energized, preventing operation of the controlled device.
- 3. REMOTE: Remote control from the PCS is enabled. The REMOTE contact closure is monitored by the PCS.
- 4. LOCAL-OFF-REMOTE Monitoring: Whenever a field-mounted L-O-R switch (local to the device) is moved out of the “REMOTE” position, an alarm shall annunciate on the PCS as amber “LOCAL” text shall appear next to the device shown on the PCS HMI graphical screens.

C. MANUAL RESET

- 1. Motors, pumps, valves, and other controlled devices that have failed or faulted due to overheating, overload, failed-to-run, pressure, flow, power supply failure, etc. are considered “unavailable” for automatic control by the PCS. The PCS will not resume normal operational control of faulted/failed device until it is manually

“reset” at the device. To manually reset the device, its L-O-R switch, local to the device, must be switched to “Off” then back to the “REMOTE” position. The PCS will immediately put the device in PCS Manual mode and in the off or closed position. The Operator must then put the device back into automatic (AUTO) mode from the PCS.

D. PROCESS EQUIPMENT STATUS

1. Equipment that is running/open to flow shall be monitored with GREEN color, and equipment that is off/closed to flow shall be RED color.
2. Equipment status shall be integrated into running time, and displayed, logged, and reported on the PCS for all equipment that have “run status” available.
3. Equipment running time shall be put into a read-only database for use by the Predictive Maintenance Software package.
4. Equipment status in the event of a loss of communications is to be individually coordinated with operations as to which systems will maintain last state, turn off, or pace a separate local variable.
5. Monitoring of analog signals are provided with 4 settable trigger/alarm setpoints.

E. TIMING FUNCTIONS

1. Timing functions shall be provided as required to provide delay periods and system checks for equipment. Timing functions shall be provided as described and where required to obtain a functional system. Timing function set points shall be adjustable through the PCS workstations and OIT's.
2. Repeat cycle timing functions shall be provided where required to obtain an adjustable “On-Period” and an adjustable “Off-Period”.

F. RUN TIME HISTORICAL LOG

1. The PCS workstations shall include a graphic screen to log and display the run-time for all equipment which the PCS is monitoring. The graphic screen shall be formatted with a summary matrix, which is organized by process type and equipment tag numbers. The PCS shall calculate the total runtime for each device running in either Hand or Auto operation. The Total Runtime shall be resettable by entering a password/access code.

G. PROCESS ALARMS

1. Mechanical equipment protection devices will be hard-wired to process equipment motor controllers and process equipment control panels under Division 26. Mechanical equipment protection devices shall not be wired to (and controlled by) the PCS unless explicitly shown on the Drawings. Process-related alarms, for example, clarifier over-torque, will be relayed from the process equipment motor controller or process equipment control panel as shown on the Drawings.
2. Display each incoming alarm as required or shown on the Piping & Instrumentation Diagrams and provide for the following tiered categories:
 - a. Priority 1 - Life Safety: for example, emergency shower alarms, hazardous gas detection, hazardous area ventilation failure. (Red background display.)
 - b. Priority 2 - Process Emergency: for example, containment area flooded, wet well high-high level, tank high-high level, basin high-high level, dry well flooded, pre-shutdown high torque, chemical dosing rate out of

- range, pump discharge check valve fails to open. (Orange background display)
- c. Priority 3 - Process Equipment Shutdown: for example, process equipment shutdown and failure alarms, shutdown on high torque, disagreement alarm. (Yellow background display)
- d. Priority 4 - Process Equipment Trouble: for example, process equipment trouble alarms, tank, basin, and wet well low-low level, DO high. (Pale Blue background)
- e. Priority 5 - Operator Attention Needed: for example, re-order chemicals, restore automatic alternation due to unequal pump running time (White background)
- 3. Alarms shall be latched in and resettable by an operator only after the alarm condition returns to normal.
- 4. "Disagreement Alarms"
 - a. Shall be generated for all process equipment that may be requested to operate and the result is monitored. Shall be generated in situations when process monitoring levels are generally expected to be the same.
 - b. Shall alarm in the event that equipment does not respond to a request within an acceptable time. For example, if a control valve is requested to close, and valve closed status does not occur within the open-to-close valve cycle time, a process equipment trouble alarm shall be initiated by the PCS.
- 5. Analog input or alarm variables shall have the following trigger points available regardless of being specifically identified or not:
 - a. High High
 - b. High
 - c. Low
 - d. Low Low
 - e. Time rate-of-change exceeded
 - f. Loss of communications, and for analog signals "out of range, i.e., 4-20 mA signals below 1 mA and above 23 mA.
- 6. A time and date stamp must be included with every alarm or message.

H. PROCESS FLOW TOTALIZING AND RECORDING

- 1. Flow shall be integrated into a total volume value, and displayed, logged, and reported on the PCS for all flow meters. In such instances as there are no flow conditions, such as pumped flow, the flow shall not totalize during such times as there is known to be no flow.
- 2. Flow shall be totalized at midnight, or as preferred by owner.

I. PROCESS PUMP CONTROL MATRIX

- 1. Provide a pump control selection matrix for each pumping station that has pumps controlled from the PCS and having common suction and discharge, similar to the following example for a four pump station:

Influent Pumps Control Matrix (For Operation of 3 Pumps Maximum)					
Influent Pump No. 1	Lead	Lag 1	Lag 2	Standby	Out of Service
Influent Pump No. 2	Lead	Lag 1	Lag 2	Standby	Out of Service

Influent Pump No. 3	Lead	Lag 1	Lag 2	Standby	Out of Service
Influent Pump No. 4	Lead	Lag 1	Lag 2	Standby	Out of service

2. Pump Alternation: alternate pump starting to equalize running time. If there is more than 100 hours of running time difference between pumps, transmit a prompt to recommend the operator change the control matrix selections. Provide control matrix interface to facilitate operator selected sequencing.

J. FAILURE RECOVERY

1. Failover: The PCS shall automatically replace a failed device with another such device in remote if available.

K. VFD ETHERNET BASED POWER MONITORING

1. At Variable Frequency Drives (VFD) provided with Ethernet connectivity to the control network the intent is to provide monitoring only through this connection.
2. Information to be monitored from each VFD with an Ethernet connection includes:
 - a. Voltage Phase A
 - b. Voltage Phase B
 - c. Voltage Phase C
 - d. Current Phase A
 - e. Current Phase B
 - f. Current Phase C
 - g. Power Factor
 - h. Power (KW)
3. Provide the following alarms:
 - a. Phase (A, B or C) Low Voltage
 - b. Current imbalance
 - c. VFD common fault

3.4 PROCESS CONTROL DESCRIPTIONS

- A. Process Control Descriptions are tabulated in the following Tables.
- B. The system shall be designed to perform the control operations as required, shown on the Drawings, specified herein, and specified in the other equipment specifications. The control logic descriptions as described below are not intended to be a complete detailed description for each piece of equipment. General Description of Operations requirements shall be applied as appropriate and directed. For example, all units that can be called to operate and have feedback shall be provided with a disagreement alarm. Timing functions and logic interlocks shall be coordinated where necessary and appropriate for a complete, functional, and operating system.
- C. In addition to the programming functions defined in this specification section and subsequent specification sections, reconfiguration and programming for the remaining I/O associated with the existing RIO systems is to be included as these are being relocated/reprogrammed to new processors. There are 185 existing I/O points not currently included in the P&ID presentation. Graphic displays, both locally at OIT and at SCADA, and monitoring of these points is to be included. See listing of existing I/O:

EXISTING NAME IN PLC	EXISTING PLC ADDRESS	UPGRADE SCOPE NOTES	LOOP NO.
A_Admin_Bldg_Pmp_1	Admin_Building:0:I.0	Related process not captured on P&ID's Existing Drainage Pump No. 1 Alarm	-
A_Admin_Bldg_Pmp_2	Admin_Building:0:I.1	Related process not captured on P&ID's Existing Drainage Pump No. 2 Alarm	-
A_Admin_Bldg_Pmp_Stn_Hi_Liq_Lvl	Admin_Building:0:I.2	Related process not captured on P&ID's Drainage Pump Station High Level Alarm	-
Spare_Node9_Slot2_Ch0	Admin_Building:2:I.Ch0Data	Related process not captured on P&ID's. Confirm functionality	
R_Aera_Tnk_Blwr_1_Run	Blower_Building:0:I.0	RIO rack to be removed	NA
A_Aera_Tnk_Blwr_1	Blower_Building:0:I.1	RIO rack to be removed	NA
R_Aera_Tnk_Blwr_2_Run	Blower_Building:0:I.2	RIO rack to be removed	NA
A_Aera_Tnk_Blwr_2	Blower_Building:0:I.3	RIO rack to be removed	NA
R_Aera_Tnk_Blwr_3_Run	Blower_Building:0:I.4	RIO rack to be removed	NA
A_Aera_Tnk_Blwr_3	Blower_Building:0:I.5	RIO rack to be removed	NA
R_Aera_Tnk_Blwr_4_Run	Blower_Building:0:I.6	RIO rack to be removed	NA
A_Aera_Tnk_Blwr_4	Blower_Building:0:I.7	RIO rack to be removed	NA
R_Dirnl_Flow_Rtentn_Tnk_Blwr_1_Run	Blower_Building:1:I.0	RIO rack to be removed	NA
A_Dirnl_Flow_Rtentn_Tnk_Blwr_1	Blower_Building:1:I.1	RIO rack to be removed	NA
R_Dirnl_Flow_Rtentn_Tnk_Blwr_2_Run	Blower_Building:1:I.2	RIO rack to be removed	NA
A_Dirnl_Flow_Rtentn_Tnk_Blwr_2	Blower_Building:1:I.3	RIO rack to be removed	NA
R_Dirnl_Flow_Rtentn_Tnk_Blwr_3_Run	Blower_Building:1:I.4	RIO rack to be removed	NA
A_Dirnl_Flow_Rtentn_Tnk_Blwr_3	Blower_Building:1:I.5	RIO rack to be removed	NA
R_Aera_Tnk_1_Air_Mass_Flow_RAW	Blower_Building:3:I.Ch0Data	RIO rack to be removed	NA
R_Aera_Tnk_2_Air_Mass_Flow_RAW	Blower_Building:3:I.Ch1Data	RIO rack to be removed	NA
R_Aera_Tnk_3_Air_Mass_Flow_RAW	Blower_Building:3:I.Ch2Data	RIO rack to be removed	NA
R_Aera_Tnk_1_Dslvd_Oxy_Flow_RAW	Blower_Building:4:I.Ch0Data	RIO rack to be removed	NA
R_Aera_Tnk_2_Dslvd_Oxy_Flow_RAW	Blower_Building:4:I.Ch1Data	RIO rack to be removed	NA
R_Aera_Tnk_3_Dslvd_Oxy_Flow_RAW	Blower_Building:4:I.Ch2Data	RIO rack to be removed	NA
R_Anero_Dgstr_Fd_Pmp_1_Run	Digester_Area:0:I.0	Related process not captured on P&ID's, Anearobic Digester Feed Pump No. 1 Running	-
A_Anero_Dgstr_Fd_Pmp_1	Digester_Area:0:I.1	Related process not captured on P&ID's	-
R_Anero_Dgstr_Fd_Pmp_2_Run	Digester_Area:0:I.2	Related process not captured on P&ID's	-
A_Anero_Dgstr_Fd_Pmp_2	Digester_Area:0:I.3	Related process not captured on P&ID's	-
R_Thkn_Sludge_Supernatent_Pump_Run	Digester_Area:0:I.4	Related process not captured on P&ID's	-
A_Thkn_Sludge_Supernatent_Pump	Digester_Area:0:I.5	Related process not captured on P&ID's	-
R_Dgstr_Gas_ComPrsor_1_Run	Digester_Area:1:I.0	Related process not captured on P&ID's	-
A_Dgstr_Gas_ComPrsor_1	Digester_Area:1:I.1	Related process not captured on	-

		P&ID's	
R_Dgstr_Gas_ComPrsor_2_Run	Digester_Area:1:I.2	Related process not captured on P&ID's	-
A_Dgstr_Gas_ComPrsor_2	Digester_Area:1:I.3	Related process not captured on P&ID's	-
R_Dgstr_Gas_ComPrsor_3_Run	Digester_Area:1:I.4	Related process not captured on P&ID's	-
A_Dgstr_Gas_ComPrsor_3	Digester_Area:1:I.5	Related process not captured on P&ID's	-
R_Thknd_Sldg_Wet_Well_Mix_1_Run	Digester_Area:2:I.0	Related process not captured on P&ID's	-
A_Thknd_Sldg_Wet_Well_Mix_1	Digester_Area:2:I.1	Related process not captured on P&ID's	-
R_Thknd_Sldg_Wet_Well_Mix_2_Run	Digester_Area:2:I.2	Related process not captured on P&ID's	-
A_Thknd_Sldg_Wet_Well_Mix_2	Digester_Area:2:I.3	Related process not captured on P&ID's	-
West_Blending_Tank_1_Mixer_On	Digester_Area:2:I.4	Associated equipment to be removed, identify as spare	NA
West_Blending_Tank_2_Mixer_On	Digester_Area:2:I.5	Associated equipment to be removed, identify as spare	NA
East_Blending_Tank_1_Mixer_On	Digester_Area:2:I.6	Associated equipment to be removed, identify as spare	NA
East_Blending_Tank_2_Mixer_On	Digester_Area:2:I.7	Associated equipment to be removed, identify as spare	NA
R_Grav_Blt_Thknr_Fd_Pmp_1_Run	Digester_Area:3:I.0	I-601	605-1
A_Grav_Blt_Thknr_Fd_Pmp_1	Digester_Area:3:I.1	I-601	605-1
R_Grav_Blt_Thknr_Fd_Pmp_2_Run	Digester_Area:3:I.2	I-601	605-2
A_Grav_Blt_Thknr_Fd_Pmp_2	Digester_Area:3:I.3	I-601	605-2
R_Grav_Blt_Thknr_Fd_Pmp_3_Run	Digester_Area:3:I.4	I-601	605-3
A_Grav_Blt_Thknr_Fd_Pmp_3	Digester_Area:3:I.5	I-601	605-3
R_Grinder_Run	Digester_Area:3:I.6	Related process not captured on P&ID's	-
A_Grinder	Digester_Area:3:I.7	Related process not captured on P&ID's	-
R_Belt_Filt_Press_Feed_Pmp_1_Run	Digester_Area:4:I.0	Related process not captured on P&ID's	-
A_Belt_Filt_Press_Feed_Pmp_1	Digester_Area:4:I.1	Related process not captured on P&ID's	-
R_Belt_Filt_Press_Feed_Pmp_2_Run	Digester_Area:4:I.2	Related process not captured on P&ID's	-
A_Belt_Filt_Press_Feed_Pmp_2	Digester_Area:4:I.3	Related process not captured on P&ID's	-
P_Prim_Digst_Lvl_High_DIO	Digester_Area:4:I.4	Related process not captured on P&ID's	-
Spare_Node6_Slot4_Ch5	Digester_Area:4:I.5	Identify as spare	-
Spare_Node6_Slot4_Ch6	Digester_Area:4:I.6	Identify as spare	-
Alm_DigesterAreaGasMonitor	Digester_Area:4:I.7	Related process not captured on P&ID's	-
R_Prim_Digstr_Lvl_RAW	Digester_Area:5:I.Ch0Data	Related process not captured on P&ID's	-
R_Sec_Digstr_Lvl_RAW	Digester_Area:5:I.Ch1Data	Related process not captured on P&ID's	-
R_Frst_Stg_Digstr_Temp_RAW	Digester_Area:5:I.Ch2Data	Related process not captured on P&ID's	-
R_Sec_Stg_Digstr_Temp_RAW	Digester_Area:5:I.Ch3Data	Related process not captured on P&ID's	-

R_Digstr_Gas_Util_Mass_Flow_RAW	Digester_Area:6:I.Ch0Data	Related process not captured on P&ID's	-
R_Digstr_Gas_Wst_Mass_Flow_RAW	Digester_Area:6:I.Ch1Data	Related process not captured on P&ID's	-
R_Digstr_1_Cover_Pos_RAW	Digester_Area:6:I.Ch2Data	Related process not captured on P&ID's	-
R_Digstr_2_Cover_Pos_RAW	Digester_Area:6:I.Ch3Data	Related process not captured on P&ID's	-
R_RSldg_To_Sldg_Bld_Flow_RAW	Digester_Area:7:I.Ch0Data	Virtual Flow (533-1 + 533-2)	532
R_WAS_To_Sldg_Bld_Flow_RAW	Digester_Area:7:I.Ch1Data	Virtual Flow (531-1 + 531-2)	530
R_Digstr_Recirc_Flow_RAW	Digester_Area:7:I.Ch2Data	Related process not captured on P&ID's	-
R_Inplant_Wtr_Pump_1_Run	Local:1:I.Data.0	Related process not captured on P&ID's	-
R_Inplant_Wtr_Pump_2_Run	Local:1:I.Data.1	Related process not captured on P&ID's	-
R_Inplant_Wtr_Pump_3_Run	Local:1:I.Data.2	Related process not captured on P&ID's	-
R_Inplant_Wtr_Pump_4_Run	Local:1:I.Data.3	Related process not captured on P&ID's	-
A_Inplant_Wtr_Pump_1	Local:1:I.Data.4	Related process not captured on P&ID's	-
A_Inplant_Wtr_Pump_2	Local:1:I.Data.5	Related process not captured on P&ID's	-
A_Inplant_Wtr_Pump_3	Local:1:I.Data.6	Related process not captured on P&ID's	-
A_Inplant_Wtr_Pump_4	Local:1:I.Data.7	Related process not captured on P&ID's	-
Preair_Influent	Local:3:O.Ch0Data	Remove local display panel and reuse to chart recorder	138+139
Raw_Influent	Local:3:O.Ch1Data	Remove local display panel and reuse to chart recorder	126
Retention_Basin_Effluent	Local:3:O.Ch2Data	Remove local display panel and reuse to chart recorder is the existing Diurnal RAW Flow	139
Final_Effluent	Local:3:O.Ch3Data	Remove local display panel and reuse to chart recorder	138
TotalRASFlow	Local:3:O.Ch4Data	Remove local display panel and identify as spare. Is the Ex. RAS Flow to Aeration	NA
TotalClarifierFlow	Local:3:O.Ch5Data	Remove local display panel and identify as spare. Is the Ex. Toatl RAS Withdraw Flow.	NA
Digstr_Feed_Flow_to_Lab	Local:4:O.Ch0Data	Remove local display panel and identify as spare	NA
GBT_Sludge_Flow_to_Lab	Local:4:O.Ch1Data	Remove local display panel and identify as spare	NA
BFP_Sludge_Flow_to_Lab	Local:4:O.Ch2Data	Remove local display panel and identify as spare	NA
GBT_Total_Flow_Small_Lab	Local:4:O.Ch3Data	Remove local display panel and identify as spare	NA
Raw_Influent_2_Lab	Local:4:O.Ch4Data	Remove local display panel and identify as spare	NA
Influent_PH_at_Lab	Local:4:O.Ch5Data	Remove local display panel and identify as spare	NA
W_Aeration_Tnk_Plug_Vlvs_1_3_SP	Local:5:O.Ch0Data	Remove existing Loop controllers, identify as spare. Note that existing signal is jumpered to 3 local position controllers.	NA

W_Sec_Clarifiers_Plug_Vlvs_1_5_SP	Local:5:O.Ch1Data	Remove existing Loop controllers, identify as spare. Note that existing signal is jumpered to 5 local position controllers.	NA
W_RAS_VFDs_1_4_PV	Local:5:O.Ch2Data	Remove existing Loop controller and VFD, identify as spare	NA
W_RAS_VFDs_2_4_PV	Local:5:O.Ch3Data	Remove existing Loop controller and VFD, identify as spare	NA
W_RAS_VFDs_3_4_PV	Local:5:O.Ch4Data	Remove existing Loop controller and VFD, identify as spare	NA
W_RAS_VFDs_4_4_PV	Local:5:O.Ch5Data	Remove existing Loop controller and VFD, use for FCV-526	NA
R_Sec_Clar_1_Undr_Flow_Mag_RAW	Local:6:I.Ch0Data	I-402	510-1
R_Sec_Clar_2_Undr_Flow_Mag_RAW	Local:6:I.Ch1Data	I-402	510-2
R_Sec_Clar_3_Undr_Flow_Mag_RAW	Local:6:I.Ch2Data	I-402	510-3
R_Sec_Clar_4_Undr_Flow_Mag_RAW	Local:6:I.Ch3Data	I-402	510-4
R_Sec_Clar_5_Undr_Flow_Mag_RAW	Local:6:I.Ch4Data	I-402	510-5
R_Hi_Rvr_Stg_WW_Lvl_RAW	Local:6:I.Ch5Data	Related process not captured on P&ID's. Is the existing High River Stage Effluent Pump Station Level.	NA
WAS_adjustment	Local:7:I.Ch0Data	See Drawing I-401, Remove existing Loop controller and use for FI-527	527
R_Pri_Clar_Coll_7_Run	Preaeration_Scum_Prim_Clarifier:0:I.2	Related process not captured on P&ID's	-
A_Pri_Clar_Coll_7_Alarm	Preaeration_Scum_Prim_Clarifier:0:I.3	Related process not captured on P&ID's	-
R_Pri_Clar_Coll_8_Run	Preaeration_Scum_Prim_Clarifier:0:I.4	Related process not captured on P&ID's	-
A_Pri_Clar_Coll_8_Alarm	Preaeration_Scum_Prim_Clarifier:0:I.5	Related process not captured on P&ID's	-
R_Scum_Pmp_1_Run	Preaeration_Scum_Prim_Clarifier:1:I.0	Related process not captured on P&ID's	-
A_Scum_Pmp_1	Preaeration_Scum_Prim_Clarifier:1:I.1	Related process not captured on P&ID's	-
R_Scum_Pmp_2_Run	Preaeration_Scum_Prim_Clarifier:1:I.2	Related process not captured on P&ID's	-
A_Scum_Pmp_2	Preaeration_Scum_Prim_Clarifier:1:I.3	Related process not captured on P&ID's	-
R_RSldg_Pmp_3_Run	Preaeration_Scum_Prim_Clarifier:1:I.4	Related process not captured on P&ID's	-
A_RSldg_Pmp_3	Preaeration_Scum_Prim_Clarifier:1:I.5	Related process not captured on P&ID's	-
R_RSldg_Pmp_4_Run	Preaeration_Scum_Prim_Clarifier:1:I.6	Related process not captured on P&ID's	-
A_RSldg_Pmp_4	Preaeration_Scum_Prim_Clarifier:1:I.7	Related process not captured on P&ID's	-
R_Scum_Cons_Coll_Run	Preaeration_Scum_Prim_Clarifier:2:I.0	Related process not captured on P&ID's	-
A_Scum_Cons_Coll	Preaeration_Scum_Prim_Clarifier:2:I.1	Related process not captured on P&ID's	-
R_RSldg_Pmp_1_Run	Preaeration_Scum_Prim_Clarifier:2:I.2	I-202	260-1
A_RSldg_Pmp_1	Preaeration_Scum_Prim_Clarifier:2:I.3	I-202	260-1
R_RSldg_Pmp_2_Run	Preaeration_Scum_Prim_Clarifier:2:I.4	I-202	260-2
A_RSldg_Pmp_2	Preaeration_Scum_Prim_Clarifier:2:I.5	I-202	260-2
R_Pri_Clar_Coll_1_2_Run_Frwd	Preaeration_Scum_Prim_Clarifier:3:I.0	Related process not captured on	-

		P&ID's	
Spare_Node2_Slot3_Ch1	Preaeration_Scum_Prim_Clarifier:3:I.1	Indicate as spare	-
A_Pri_Clar_Coll_1_2	Preaeration_Scum_Prim_Clarifier:3:I.2	Related process not captured on P&ID's	-
R_Pri_Clar_Coll_3_4_Run_Frwd	Preaeration_Scum_Prim_Clarifier:3:I.3	Related process not captured on P&ID's	-
Spare_Node2_Slot3_Ch4	Preaeration_Scum_Prim_Clarifier:3:I.4	Related process not captured on P&ID's	-
A_Pri_Clar_Coll_3_4	Preaeration_Scum_Prim_Clarifier:3:I.5	Related process not captured on P&ID's	-
A_Sludge_Pump_Bldg1_Gas	Preaeration_Scum_Prim_Clarifier:3:I.6	Related process not captured on P&ID's	-
R_Pri_Clar_Coll_5_6_Run_Frwd	Preaeration_Scum_Prim_Clarifier:4:I.0	Related process not captured on P&ID's	-
Spare_Node2_Slo4_Ch1	Preaeration_Scum_Prim_Clarifier:4:I.1	Indicate as spare	-
A_Pri_Clar_Coll_5_6	Preaeration_Scum_Prim_Clarifier:4:I.2	Related process not captured on P&ID's	-
R_Ras_Pmp_1_Run	RAS_Secondary_Clarifier:0:I.0	Existing variable frequency drive to be replaced, make spare	NA
A_Ras_Pmp_1	RAS_Secondary_Clarifier:0:I.1	Existing variable frequency drive to be replaced, make spare	NA
R_Ras_Pmp_2_Run	RAS_Secondary_Clarifier:0:I.2	Existing variable frequency drive to be replaced, make spare	NA
A_Ras_Pmp_2	RAS_Secondary_Clarifier:0:I.3	Existing variable frequency drive to be replaced, make spare	NA
R_Ras_Pmp_3_Run	RAS_Secondary_Clarifier:0:I.4	Existing variable frequency drive to be replaced, make spare	NA
A_Ras_Pmp_3	RAS_Secondary_Clarifier:0:I.5	Existing variable frequency drive to be replaced, make spare	NA
R_Ras_Pmp_4_Run	RAS_Secondary_Clarifier:0:I.6	Existing variable frequency drive to be replaced, make spare	NA
A_Ras_Pmp_4	RAS_Secondary_Clarifier:0:I.7	Existing variable frequency drive to be replaced, make spare	NA
R_Ras_Pmp_5_Run	RAS_Secondary_Clarifier:1:I.0	Existing variable frequency drive to be replaced, make spare	NA
A_Ras_Pmp_5	RAS_Secondary_Clarifier:1:I.1	Existing variable frequency drive to be replaced, make spare	NA
A_RAS_Meter_Chmbr_High_Water	RAS_Secondary_Clarifier:1:I.2	Make spare	NA
A_RAS_WW_LowLevel	RAS_Secondary_Clarifier:1:I.3	Make spare	NA
R_Sec_Clar_1_Run	RAS_Secondary_Clarifier:1:I.4	Related process not captured on P&ID's	-
A_Sec_Clar_1	RAS_Secondary_Clarifier:1:I.5	Related process not captured on P&ID's	-
R_Sec_Clar_2_Run	RAS_Secondary_Clarifier:1:I.6	Related process not captured on P&ID's	-
A_Sec_Clar_2	RAS_Secondary_Clarifier:1:I.7	Related process not captured on P&ID's	-
R_Sec_Clar_3_Run	RAS_Secondary_Clarifier:2:I.0	Related process not captured on P&ID's	-
A_Sec_Clar_3	RAS_Secondary_Clarifier:2:I.1	Related process not captured on P&ID's	-
R_Sec_Clar_4_Run	RAS_Secondary_Clarifier:2:I.2	Related process not captured on P&ID's	-
A_Sec_Clar_4	RAS_Secondary_Clarifier:2:I.3	Related process not captured on P&ID's	-
R_Sec_Clar_5_Run	RAS_Secondary_Clarifier:2:I.4	Related process not captured on P&ID's	-
A_Sec_Clar_5	RAS_Secondary_Clarifier:2:I.5	Related process not captured on	-

		P&ID's	
R_Plnt_Efflnt_Pmp_1_Run	RAS_Secondary_Clarifier:3:I.0	Related process not captured on P&ID's	-
A_Plnt_Efflnt_Pmp_1	RAS_Secondary_Clarifier:3:I.1	Related process not captured on P&ID's	-
R_Plnt_Efflnt_Pmp_2_Run	RAS_Secondary_Clarifier:3:I.2	Related process not captured on P&ID's	-
A_Plnt_Efflnt_Pmp_2	RAS_Secondary_Clarifier:3:I.3	Related process not captured on P&ID's	-
R_Plnt_Efflnt_Pmp_3_Run	RAS_Secondary_Clarifier:3:I.4	Related process not captured on P&ID's	-
A_Plnt_Efflnt_Pmp_3	RAS_Secondary_Clarifier:3:I.5	Related process not captured on P&ID's	-
R_Aera_Tnk_1_RAS_Flow_RAW	RAS_Secondary_Clarifier:5:I.Ch0Data	Existing meter to be removed, indicate as spare	NA
R_Aera_Tnk_2_RAS_Flow_RAW	RAS_Secondary_Clarifier:5:I.Ch1Data	Existing meter to be removed, indicate as spare	NA
R_Aera_Tnk_3_RAS_Flow_RAW	RAS_Secondary_Clarifier:5:I.Ch2Data	Existing meter to be removed, indicate as spare	NA
R_NPW_Wet_Well_Lvl_RAW	RAS_Secondary_Clarifier:5:I.Ch3Data	Related process not captured on P&ID's	-
R_Dirnl_Flow_Rtentn_Pmp_1_Run	Retention_Tanks:0:I.0	I-103	145-1
R_Dirnl_Flow_Rtentn_Pmp_2_Run	Retention_Tanks:0:I.1	I-103	145-2
R_Dirnl_Flow_Rtentn_Pmp_3_Run	Retention_Tanks:0:I.2	I-103	145-3
A_Dirnl_Flow_Rtentn_Pmp_1	Retention_Tanks:0:I.3	I-103	145-1
A_Dirnl_Flow_Rtentn_Pmp_2	Retention_Tanks:0:I.4	I-103	145-2
A_Dirnl_Flow_Rtentn_Pmp_3	Retention_Tanks:0:I.5	I-103	145-3
R_Storm_Flow_Rtentn_Tnk_Pmp_1_Run	Retention_Tanks:1:I.0	I-103	155-1
R_Storm_Flow_Rtentn_Tnk_Pmp_2_Run	Retention_Tanks:1:I.1	I-103	155-2
A_Storm_Flow_Rtentn_Tnk_Pmp_1	Retention_Tanks:1:I.2	I-103	155-1
A_Storm_Flow_Rtentn_Tnk_Pmp_2	Retention_Tanks:1:I.3	I-103	155-2
R_Strm_Flow_Rtentn_Tnk_Wtr_Lvl_RAW	Retention_Tanks:2:I.Ch0Data	I-103	150
R_Rtentn_Bsn_Efflnt_Flow_RAW	Retention_Tanks:2:I.Ch1Data	I-103	153
R_Flow_Rtentn_Bsn_Efflnt_Lvl_RAW	Retention_Tanks:2:I.Ch2Data	I-103	151
Influent_Trunk_at_Retention_Basin	Retention_Tanks:3:O.Ch0Data	Not used Identify as spare	NA
Raw_Influent_2	Retention_Tanks:3:O.Ch1Data	I-103 scale values for proper display at local panel	138
Bypass_Flow_at_Retention	Retention_Tanks:3:O.Ch2Data	I-103 scale values for proper display at local panel	125
Preair_Infl_Flow_at_Retention	Retention_Tanks:3:O.Ch3Data	I-103 scale values for proper display at local panel	280A
R_Influent_Scrw_Pmp_1_Run	Screen_Grit:0:I.0	I-101	115-1
R_Influent_Scrw_Pmp_2_Run	Screen_Grit:0:I.1	I-101	115-2
A_Inflt_Scrw_Pmp_1_Lube_Oil_Spd	Screen_Grit:0:I.2	I-101	115-1
A_Inflt_Scrw_Pmp_2_Lube_Oil_Spd	Screen_Grit:0:I.3	I-101	115-2
R_Inflt_Mech_BScrn_1_Run	Screen_Grit:0:I.4	I-101	120-1
A_Inflt_Mech_BScrn_1_OL	Screen_Grit:0:I.5	I-101	120-1
A_Inflt_Mech_BScrn_1_Hi_Lvl	Screen_Grit:0:I.6	I-101	120-1
InfltMechBarScrn1_Hi_Level	Screen_Grit:0:I.7	Not used, identify as spare	NA
R_Inflt_Mech_BScrn_2_Run	Screen_Grit:1:I.0	I-101	120-2

A_Inflt_Mech_BScrn_2_OL	Screen_Grit:1:I.1	I-101	120-2
A_Inflt_Mech_BScrn_2_Hi_Lvl	Screen_Grit:1:I.2	I-101	120-2
InfltMechBarScrn2_Hi_Level	Screen_Grit:1:I.3	Not used, identify as spare	NA
R_BScrn_Cnvr_Run	Screen_Grit:1:I.4	I-101	121
Spare_Node1_Slot1_Ch5	Screen_Grit:1:I.5	Not used, identify as spare	NA
R_Grit_Tnk_1_Organic_Pmp_Run	Screen_Grit:1:I.6	I-101	131-1
R_Grit_Tnk_2_Organic_Pmp_Run	Screen_Grit:1:I.7	I-101	131-2
R_Grit_Tnk_1_Dwtr_Coll_Drv_3_Run	Screen_Grit:2:I.0	I-101	130-1
A_Grit_Tnk_1_Dwtr_Coll_Drv_3	Screen_Grit:2:I.1	I-101	130-1
R_Grit_Tnk_2_Dwtr_Coll_Drv_3_Run	Screen_Grit:2:I.2	I-101	130-2
A_Grit_Tnk_2_Dwtr_Coll_Drv_3	Screen_Grit:2:I.3	I-101	130-2
R_Dwtr_Grit_Tnk_Scrw_Cnvr_1_Run	Screen_Grit:2:I.4	I-101	136-1
A_Dwtr_Grit_Tnk_Scrw_Cnvr_1	Screen_Grit:2:I.5	I-101	136-1
R_Dwtr_Grit_Tnk_Scrw_Cnvr_2_Run	Screen_Grit:2:I.6	I-101	136-2
A_Dwtr_Grit_Tnk_Scrw_Cnvr_2	Screen_Grit:2:I.7	I-101	136-2
R_Dwtr_Grit_Xfer_Scrw_Cnvr_Run	Screen_Grit:3:I.0	I-101	137
A_Dwtr_Grit_Xfer_Scrw_Cnvr_Lo_Spd	Screen_Grit:3:I.1	I-101	137
R_HWrks_Odor_Cntl_Blwr_Run	Screen_Grit:3:I.2	I-101, Reuse existing I/O point for new equipment	101
A_HWrks_Odor_Cntl_Blwr	Screen_Grit:3:I.3	I-101, Reuse exisintg I/O point for new equipment.	101
A_HWrks_Gas_Alarms	Screen_Grit:3:I.4	I-102	100
R_Inflnt_Tnk_Sewer_Lvl_RAW	Screen_Grit:4:I.Ch0Data	I-101	110
R_Inflnt_Tnk_Flow_RAW	Screen_Grit:4:I.Ch1Data	Not used identify as spare	NA
Grit_Tank_1_Flow_Meter	Screen_Grit:4:I.Ch2Data	I-101	135
Grit_Tank_2_Flow_Meter	Screen_Grit:4:I.Ch3Data	I-101	135
R_Inflnt_pH_Raw_WW_Scrw_Pmps_RAW	Screen_Grit:5:I.Ch0Data	Equipment to be removed, identify as spare	NA
R_Inflnt_Temp_Raw_WW_Scrw_Pmps_RAW	Screen_Grit:5:I.Ch1Data	Equipment to be removed, identify as spare	NA
R_Rtentn_Byp_Flow_RAW	Screen_Grit:5:I.Ch2Data	I-101	139
R_Secondary_Byp_Flow_RAW	Screen_Grit:5:I.Ch3Data	I-101	125
An_Influent_Bar_Screen_in_High_Alarm	Screen_Grit:6:O.0	Point not captured on P&ID's	-
At_Least_1_1st_Stage_Screw_P_Is_Running	Screen_Grit:6:O.1	I-101 Reprogram point to be PEPS 'ok'/Enable to Influent Screens	115
At_Least_1_2nd_Stage_Screw_P_Is_Running	Screen_Grit:6:O.2	Not used, identify as spare	NA
Ras_Metering_Chamber_High_Water_Alarm	Screen_Grit:6:O.3	Not used, identify as spare	NA
Filtrate_Pump_Hi_Low_Level_Alarm	Screen_Grit:6:O.4	Not used, identify as spare	NA
At_Least_1_Influent_Screw_P_Is_Running	Screen_Grit:6:O.5	Not used, identify as spare	NA
R_FStg_Scrw_Pmp_1_Run	Screw_Pumps_Aeration_Mixers:0:I.0	RIO rack to be removed	NA
A_FStg_Scrw_Pmp_1_Lo_Spd	Screw_Pumps_Aeration_Mixers:0:I.1	RIO rack to be removed	NA
R_FStg_Scrw_Pmp_2_Run	Screw_Pumps_Aeration_Mixers:0:I.2	RIO rack to be removed	NA
A_FStg_Scrw_Pmp_2_Lo_Spd	Screw_Pumps_Aeration_Mixers:0:I.3	RIO rack to be removed	NA
R_Sec_Stg_Scrw_Pmp_1_Run	Screw_Pumps_Aeration_Mixers:0:I.4	RIO rack to be removed	NA
A_Sec_Stg_Scrw_Pmp_1_Lo_Spd	Screw_Pumps_Aeration_Mixers:0:I.5	RIO rack to be removed	NA

R_Sec_Stg_Scrw_Pmp_2_Run	Screw_Pumps_Aeration_Mixers:0:I.6	RIO rack to be removed	NA
A_Sec_Stg_Scrw_Pmp_2_Lo_Spd	Screw_Pumps_Aeration_Mixers:0:I.7	RIO rack to be removed	NA
R_Aera_Tnk_Mix_1_Run	Screw_Pumps_Aeration_Mixers:1:I.0	RIO rack to be removed	NA
A_Aera_Tnk_Mix_1	Screw_Pumps_Aeration_Mixers:1:I.1	RIO rack to be removed	NA
R_Aera_Tnk_Mix_2_Run	Screw_Pumps_Aeration_Mixers:1:I.2	RIO rack to be removed	NA
A_Aera_Tnk_Mix_2	Screw_Pumps_Aeration_Mixers:1:I.3	RIO rack to be removed	NA
R_Aera_Tnk_Mix_3_Run	Screw_Pumps_Aeration_Mixers:1:I.4	RIO rack to be removed	NA
A_Aera_Tnk_Mix_3	Screw_Pumps_Aeration_Mixers:1:I.5	RIO rack to be removed	NA
At_Least_1_Raw_Sludge_Pump_Running	Screw_Pumps_Aeration_Mixers:2:O.0	RIO rack to be removed	NA
Admin_Pump_Station_High_Level	Screw_Pumps_Aeration_Mixers:2:O.1	RIO rack to be removed	NA
RAS_Metering_High_Water	Screw_Pumps_Aeration_Mixers:2:O.2	RIO rack to be removed	NA
Filtrate_Pump_Hi_Lo_Level	Screw_Pumps_Aeration_Mixers:2:O.3	RIO rack to be removed	NA
At_Least_1_Bar_Screen_is_in_Alarm	Screw_Pumps_Aeration_Mixers:2:O.4	RIO rack to be removed	NA
At_Least_1_Raw_Screw_Running	Screw_Pumps_Aeration_Mixers:2:O.5	RIO rack to be removed	NA
Gas_Alarms	Screw_Pumps_Aeration_Mixers:2:O.6	RIO rack to be removed	NA
R_Recirc_Pmp_1_Run	Solids_Handling_Unit_1:0:I.0	Related process not captured on P&ID's	-
A_Recirc_Pmp_1	Solids_Handling_Unit_1:0:I.1	Related process not captured on P&ID's	-
R_Recirc_Pmp_2_Run	Solids_Handling_Unit_1:0:I.2	Related process not captured on P&ID's	-
A_Recirc_Pmp_2	Solids_Handling_Unit_1:0:I.3	Related process not captured on P&ID's	-
R_Boiler_Unit_1_Run	Solids_Handling_Unit_1:0:I.4	Not used, identify as spare	NA
A_Boiler_Unit_1	Solids_Handling_Unit_1:0:I.5	Not used, identify as spare	NA
R_Boiler_Unit_2_Run	Solids_Handling_Unit_1:0:I.6	Not used, identify as spare	NA
A_Boiler_Unit_2	Solids_Handling_Unit_1:0:I.7	Not used, identify as spare	NA
R_Boiler_Unit_3_Run	Solids_Handling_Unit_1:1:I.0	Not used, identify as spare	NA
A_Boiler_Unit_3	Solids_Handling_Unit_1:1:I.1	Not used, identify as spare	NA
R_Liq_Bulk_Poly_Xfer_Pmp_1_Run	Solids_Handling_Unit_1:1:I.2	Related process not captured on P&ID's	-
A_Liq_Bulk_Poly_Xfer_Pmp_1	Solids_Handling_Unit_1:1:I.3	Related process not captured on P&ID's	-
R_Liq_Bulk_Poly_Xfer_Pmp_2_Run	Solids_Handling_Unit_1:1:I.4	Related process not captured on P&ID's	-
A_Liq_Bulk_Poly_Xfer_Pmp_2	Solids_Handling_Unit_1:1:I.5	Related process not captured on P&ID's	-
R_Liq_Bulk_Poly_Xfer_Pmp_3_Run	Solids_Handling_Unit_1:1:I.6	Related process not captured on P&ID's	-
A_Liq_Bulk_Poly_Xfer_Pmp_3	Solids_Handling_Unit_1:1:I.7	Related process not captured on P&ID's	-
R_Poly_Sol_Pmp_1_Run	Solids_Handling_Unit_1:2:I.0	Related process not captured on P&ID's	-
A_Poly_Sol_Pmp_1	Solids_Handling_Unit_1:2:I.1	Related process not captured on P&ID's	-
R_Poly_Sol_Pmp_2_Run	Solids_Handling_Unit_1:2:I.2	Related process not captured on P&ID's	-
A_Poly_Sol_Pmp_2	Solids_Handling_Unit_1:2:I.3	Related process not captured on P&ID's	-
R_Poly_Sol_Pmp_3_Run	Solids_Handling_Unit_1:2:I.4	Related process not captured on P&ID's	-
A_Poly_Sol_Pmp_3	Solids_Handling_Unit_1:2:I.5	Related process not captured on	-

		P&ID's	
R_Poly_Sol_Pmp_4_Run	Solids_Handling_Unit_1:2:I.6	Related process not captured on P&ID's	-
A_Poly_Sol_Pmp_4	Solids_Handling_Unit_1:2:I.7	Related process not captured on P&ID's	-
Spare_Node4_Slot3_Ch0	Solids_Handling_Unit_1:3:I.0	Not used, identify as spare	NA
Spare_Node4_Slot3_Ch1	Solids_Handling_Unit_1:3:I.1	Not used, identify as spare	NA
R_Solids_Hndlg_Odor_Cntl_Run	Solids_Handling_Unit_1:3:I.2	Not used, identify as spare	NA
A_Solids_Handling_Odor_Cntl	Solids_Handling_Unit_1:3:I.3	Not used, identify as spare	NA
A_Solids_Gas_Monitor	Solids_Handling_Unit_1:3:I.4	Related process not captured on P&ID's	-
R_SStrm_Tnk_Mixer1_Run	Solids_Handling_Unit_1:3:I.5	Related process not captured on P&ID's	-
A_SStrm_Tnk_Mixer1	Solids_Handling_Unit_1:3:I.6	Related process not captured on P&ID's	-
R_Filtrate_Pmp_1_Run	Solids_Handling_Unit_1:4:I.0	Related process not captured on P&ID's	-
A_Filtrate_Pmp_1and2_Alarm	Solids_Handling_Unit_1:4:I.1	Related process not captured on P&ID's	-
R_Filtrate_Pmp_2_Run	Solids_Handling_Unit_1:4:I.2	Related process not captured on P&ID's	-
A_Filtrate_Pmp_1and2_HiLo_Alarm	Solids_Handling_Unit_1:4:I.3	Related process not captured on P&ID's	-
R_SStrm_Tnk_Mixer2_Run	Solids_Handling_Unit_1:4:I.4	Related process not captured on P&ID's	-
A_SStrm_Tnk_Mixer2	Solids_Handling_Unit_1:4:I.5	Related process not captured on P&ID's	-
R_SStrm_Tnk_Mixer3_Run	Solids_Handling_Unit_1:4:I.6	Related process not captured on P&ID's	-
A_SStrm_Tnk_Mixer3	Solids_Handling_Unit_1:4:I.7	Related process not captured on P&ID's	-
R_SStrm_Pump_1_Run	Solids_Handling_Unit_1:5:I.0	Related process not captured on P&ID's	-
A_SStrm_Pump_1	Solids_Handling_Unit_1:5:I.1	Related process not captured on P&ID's	-
R_SStrm_Pump_2_Run	Solids_Handling_Unit_1:5:I.2	Related process not captured on P&ID's	-
A_SStrm_Pump_2	Solids_Handling_Unit_1:5:I.3	Related process not captured on P&ID's	-
R_Thknd_Sldg_WW_Lvl_RAW	Solids_Handling_Unit_1:6:I.Ch0Data	Related process not captured on P&ID's	-
R_Sidestream_Tank_Level_RAW	Solids_Handling_Unit_1:6:I.Ch1Data	Related process not captured on P&ID's	-
Spare_Node4_Slot4_Ch2	Solids_Handling_Unit_1:6:I.Ch2Data	Not used, identify as spare	NA
Spare_Node4_Slot4_Ch3	Solids_Handling_Unit_1:6:I.Ch3Data	Not used, identify as spare	NA
R_Grav_Blt_Thknr_Drv_1_Run	Solids_Handling_Unit_2:0:I.0	Related process not captured on P&ID's	-
A_Grav_Blt_Thknr_Drv_1	Solids_Handling_Unit_2:0:I.1	Related process not captured on P&ID's	-
R_Grav_Blt_Thknr_Drv_2_Run	Solids_Handling_Unit_2:0:I.2	Related process not captured on P&ID's	-
A_Grav_Blt_Thknr_Drv_2	Solids_Handling_Unit_2:0:I.3	Related process not captured on P&ID's	-
R_Grav_Blt_Thknr_Hyd_1_Run	Solids_Handling_Unit_2:0:I.4	Related process not captured on P&ID's	-
A_Grav_Blt_Thknr_Hyd_1	Solids_Handling_Unit_2:0:I.5	Related process not captured on P&ID's	-

R_Grav_Blt_Thknr_Hyd_2_Run	Solids_Handling_Unit_2:0:I.6	Related process not captured on P&ID's	-
A_Grav_Blt_Thknr_Hyd_2	Solids_Handling_Unit_2:0:I.7	Related process not captured on P&ID's	-
R_Grav_Blt_Thknr_WWtr_Bstr_Pmp_1_Run	Solids_Handling_Unit_2:1:I.0	Related process not captured on P&ID's	-
A_Grav_Blt_Thknr_WWtr_Bstr_Pmp_1	Solids_Handling_Unit_2:1:I.1	Related process not captured on P&ID's	-
R_Grav_Blt_Thknr_WWtr_Bstr_Pmp_2_Run	Solids_Handling_Unit_2:1:I.2	Related process not captured on P&ID's	-
A_Grav_Blt_Thknr_WWtr_Bstr_Pmp_2	Solids_Handling_Unit_2:1:I.3	Related process not captured on P&ID's	-
A_Grav_Blt_Thknr_Low_FLo	Solids_Handling_Unit_2:1:I.4	Related process not captured on P&ID's	-
R_GBT_Dil_Prep_Mod_Run	Solids_Handling_Unit_2:1:I.5	Related process not captured on P&ID's	-
A_GBT_Dil_Prep_Mod	Solids_Handling_Unit_2:1:I.6	Related process not captured on P&ID's	-
R_Thknr_Diltm_Mtr_Mod_1_Run	Solids_Handling_Unit_2:2:I.0	Related process not captured on P&ID's	-
A_Thknr_Diltm_Mtr_Mod_1	Solids_Handling_Unit_2:2:I.1	Related process not captured on P&ID's	-
R_Thknr_Diltm_Mtr_Mod_2_Run	Solids_Handling_Unit_2:2:I.2	Related process not captured on P&ID's	-
A_Thknr_Diltm_Mtr_Mod_2	Solids_Handling_Unit_2:2:I.3	Related process not captured on P&ID's	-
R_Fltring_Prs_Mtr_Mod_1_Run	Solids_Handling_Unit_2:2:I.4	Related process not captured on P&ID's	-
A_Fltring_Prs_Mtr_Mod_1	Solids_Handling_Unit_2:2:I.5	Related process not captured on P&ID's	-
R_Fltring_Prs_Mtr_Mod_2_Run	Solids_Handling_Unit_2:2:I.6	Related process not captured on P&ID's	-
A_Fltring_Prs_Mtr_Mod_2	Solids_Handling_Unit_2:2:I.7	Related process not captured on P&ID's	-
R_Blt_Fltr_Prs_1_Drv_Run	Solids_Handling_Unit_2:3:I.0	Related process not captured on P&ID's	-
A_Blt_Fltr_Prs_1_Dr	Solids_Handling_Unit_2:3:I.1	Related process not captured on P&ID's	-
R_Blt_Fltr_Prs_2_Drv_Run	Solids_Handling_Unit_2:3:I.2	Related process not captured on P&ID's	-
A_Blt_Fltr_Prs_2_Dr	Solids_Handling_Unit_2:3:I.3	Related process not captured on P&ID's	-
R_Blt_Fltr_Prs_WWtr_Bstr_Pmp_1_Run	Solids_Handling_Unit_2:3:I.4	Related process not captured on P&ID's	-
A_Blt_Fltr_Prs_WWtr_Bstr_Pmp_1	Solids_Handling_Unit_2:3:I.5	Related process not captured on P&ID's	-
R_Blt_Fltr_Prs_WWtr_Bstr_Pmp_2_Run	Solids_Handling_Unit_2:3:I.6	Related process not captured on P&ID's	-
A_Blt_Fltr_Prs_WWtr_Bstr_Pmp_2	Solids_Handling_Unit_2:3:I.7	Related process not captured on P&ID's	-
R_Thick_Sludge_Pmp_1_Run	Solids_Handling_Unit_2:4:I.0	Related process not captured on P&ID's	-
A_Thick_Sludge_Pmp_1	Solids_Handling_Unit_2:4:I.1	Related process not captured on P&ID's	-
R_Thick_Sludge_Pmp_2_Run	Solids_Handling_Unit_2:4:I.2	Related process not captured on P&ID's	-
A_Thick_Sludge_Pmp_2	Solids_Handling_Unit_2:4:I.3	Related process not captured on P&ID's	-
A_Blt_Fltr_Prs_Low_Flow	Solids_Handling_Unit_2:4:I.4	Related process not captured on P&ID's	-

R_BFP_Dil_Prep_Mod_Run	Solids_Handling_Unit_2:4:I.5	Related process not captured on P&ID's	-
A_BFP_Dil_Prep_Mod	Solids_Handling_Unit_2:4:I.6	Related process not captured on P&ID's	-
R_Incline_Sldg_Ck_Cnvr_A_Mtr_Run	Solids_Handling_Unit_2:5:I.0	Related process not captured on P&ID's	-
A_Incline_Sldg_Ck_Cnvr_A_Mtr	Solids_Handling_Unit_2:5:I.1	Related process not captured on P&ID's	-
R_Incline_Sldg_Ck_Cnvr_B_Rvrs_Mtr_Run	Solids_Handling_Unit_2:5:I.2	Related process not captured on P&ID's	-
A_Incline_Sldg_Ck_Cnvr_B_Rvrs_Mtr	Solids_Handling_Unit_2:5:I.3	Related process not captured on P&ID's	-
R_Sldg_Ck_Scrw_Cnvr_1_C_Run	Solids_Handling_Unit_2:5:I.4	Related process not captured on P&ID's	-
A_Sldg_Ck_Scrw_Cnvr_1_C	Solids_Handling_Unit_2:5:I.5	Related process not captured on P&ID's	-
R_Sldg_Ck_Scrw_Cnvr_2_D_Run	Solids_Handling_Unit_2:5:I.6	Related process not captured on P&ID's	-
A_Sldg_Ck_Scrw_Cnvr_2_D	Solids_Handling_Unit_2:5:I.7	Related process not captured on P&ID's	-
R_GBT_Cont_Panel_Sludge_Flow_RAW	Solids_Handling_Unit_2:6:I.Ch1Data	Related process not captured on P&ID's	-
R_BFP_Cont_Panel_Sludge_Flow_RAW	Solids_Handling_Unit_2:6:I.Ch2Data	Related process not captured on P&ID's	-
R_Digester_Feed_Flow_RAW	Solids_Handling_Unit_2:6:I.Ch3Data	Related process not captured on P&ID's	-
R_Grav_Blt_Thknr_1_Dschg_Flow_RAW	Solids_Handling_Unit_2:7:I.Ch0Data	Related process not captured on P&ID's	-
R_Grav_Blt_Thknr_2_Dschg_Flow_RAW	Solids_Handling_Unit_2:7:I.Ch1Data	Related process not captured on P&ID's	-
R_Sldg_Blending_Tnk1_RAW	Solids_Handling_Unit_2:7:I.Ch2Data	Related process not captured on P&ID's	-
R_Sldg_Blending_Tnk2_RAW	Solids_Handling_Unit_2:7:I.Ch3Data	Related process not captured on P&ID's	-
R_TertFltr_1_BridgePrewashPump_Run	Tertiary_Filter_UV:0:I.0	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_1_WashWtr_Pump_Run	Tertiary_Filter_UV:0:I.1	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_2_Prewash_Pump_Run	Tertiary_Filter_UV:0:I.2	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_2_WashWtr_Pump_Run	Tertiary_Filter_UV:0:I.3	Existing Filter to be removed, mark as spare	NA
R_UV_Run_Input	Tertiary_Filter_UV:0:I.4	I-501	490
A_UV_Input	Tertiary_Filter_UV:0:I.5	I-501	490
R_Tert_Fltr_1_Carriage_Drv_Run	Tertiary_Filter_UV:1:I.0	Existing Filter to be removed, mark as spare	NA
A_Tert_Fltr_1_Filter	Tertiary_Filter_UV:1:I.1	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_2_Carriage_Drv_Run	Tertiary_Filter_UV:1:I.2	Existing Filter to be removed, mark as spare	NA
A_Tert_Fltr_2_Filter	Tertiary_Filter_UV:1:I.3	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_3_Carriage_Drv_Run	Tertiary_Filter_UV:1:I.4	Existing Filter to be removed, mark as spare	NA
A_Tert_Fltr_3_Filter	Tertiary_Filter_UV:1:I.5	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_3_Prewash_Pump_Run	Tertiary_Filter_UV:1:I.6	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_3_Washwtr_Pump_Run	Tertiary_Filter_UV:1:I.7	Existing Filter to be removed, mark as spare	NA

R_Tert_Fltr_1_Skm_Pump_Run	Tertiary_Filter_UV:3:I.0	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_1_Chem_Feed_Pump_Run	Tertiary_Filter_UV:3:I.1	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_2_Skm_Pump_Run	Tertiary_Filter_UV:3:I.2	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_2_Chem_Feed_Pump_Run	Tertiary_Filter_UV:3:I.3	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_3_Skm_Pump_Run	Tertiary_Filter_UV:3:I.4	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_3_Chem_Feed_Pump_Run	Tertiary_Filter_UV:3:I.5	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_1_BckWsh_Pump_Run	Tertiary_Filter_UV:4:I.0	Existing Filter to be removed, mark as spare	NA
A_Tert_Fltr_1_Filter_Hi_Lvl	Tertiary_Filter_UV:4:I.1	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_2_BckWsh_Pump_Run	Tertiary_Filter_UV:4:I.2	Existing Filter to be removed, mark as spare	NA
A_Tert_Fltr_2_Filter_Hi_Lvl	Tertiary_Filter_UV:4:I.3	Existing Filter to be removed, mark as spare	NA
R_Tert_Fltr_3_BckWsh_Pump_Run	Tertiary_Filter_UV:4:I.4	Existing Filter to be removed, mark as spare	NA
A_Tert_Fltr_3_Filter_Hi_Lvl	Tertiary_Filter_UV:4:I.5	Existing Filter to be removed, mark as spare	NA
R_Plant_Effluent_Flow_RAW	Tertiary_Filter_UV:5:I.Ch0Data	Related process not captured on P&ID's	-
R_Plant_Effluent_Samp_Dis_O2_RAW	Tertiary_Filter_UV:5:I.Ch1Data	Related process not captured on P&ID's	-
R_Plant_Effluent_Samp_pH_RAW	Tertiary_Filter_UV:5:I.Ch2Data	Related process not captured on P&ID's	-
R_SStrm_Recycle_Flow_RAW	Tertiary_Filter_UV:5:I.Ch3Data	Related process not captured on P&ID's	-

- D. In addition to the programming functions defined in this specification section and subsequent specification sections, programming for I/O configuration, graphic displays and control functions not yet identified shall be provided upon request. Such additional I/O, displays and functions may be identified by the Engineer or the Owner throughout the construction process at any point prior to substantial completion. Additional programming to be identified during the construction phase as defined herein shall be provided at no additional cost to the Owner. For the purposes of bidding this level of effort the CSI shall reserve an additional **100 hours of otherwise unallocated time** for the purpose of responding to comments outside of the defined scope.

Loop No. 100	Hazardous Gas Alarms – Headworks
Monitoring	Refer to Piping & Instrumentation Diagrams.

Loop No. 101	Odor Control – Headworks
Monitoring	Refer to Piping & Instrumentation Diagrams. Reuse RIO inputs for Odor Control.

Loop No. 110	Headworks Influent Channel Level
Monitoring	Refer to Piping & Instrumentation Diagrams. Display level (feet) in the “Influent Channel Level Controller”. Display level (feet) at SCADA.

Loop No. 114	Influent Channel Gates
Monitoring	Refer to Piping & Instrumentation Diagrams Display gate position (open/close) in the “Influent Channel Level Controller” by means of pilot lights. Display gate position (open/close) at SCADA.
PCS MANUAL	Open and close gate

Loop No. 115	Headworks Influent Screw Pumps
Monitoring	Refer to Piping & Instrumentation Diagrams. Alarm if not enabled. Enable if: • All IFAS levels (LI-320/LSHH-320) are below High High Alarm; reset after IFAS levels drop below Hi1 for time (30 minutes) • At least one PEPS Pump is in Auto without fault; • PEPS Wet Well has not been above high level for 2 minutes or at HiHi Level; reset below the wet well level control setpoint maintained for 5 minutes. • Fine Screen Building below High Level Alarm (LI-160), reset after 10 minutes.
Interlock	Stop pumps when all three Primary Effluent Pumps are off.

Loop No. 120	Headworks Mechanical Bar Screens
Monitoring	Refer to Piping & Instrumentation Diagrams.

Loop No. 121	Headworks Screenings Conveyor
Monitoring	Refer to Piping & Instrumentation Diagrams.

Loop No. 125	Plant Bypass Flow to Tuscarawas River
Monitoring	Refer to Piping & Instrumentation Diagrams. Reuse existing I/O for same purpose. Provide resettable flow totalizer.

Loop No. 126	Bypass Gate to River (provide programming to use existing I/O for a new gate actuator not being provided under this contract)
Monitoring	Refer to Piping & Instrumentation Diagrams
PCS AUTO	Open gate on High Alarm from LI-150
PCS MANUAL	Open and close gate

Loop No. 130	Grit Tanks
Monitoring	Refer to Piping & Instrumentation Diagrams.

Loop No. 136	Grit Conveyors
Monitoring	Refer to Piping & Instrumentation Diagrams.

Loop No. 137	Grit Screw Transfer Conveyor
Monitoring	Refer to Piping & Instrumentation Diagrams.

Loop No. 138	Headworks Effluent Flow
Monitoring	Refer to Piping & Instrumentation Diagrams. New flow meter replaces existing meter, reuse the associated input. Use (FI-138 + FI-139) as Plant Influent Flow. Provide trend for this and for (FI-125 + FI-138 + FI-139). Provide resettable flow totalizer for each.

Loop No. 139	Retention Basin Influent Flow
Monitoring	Refer to Piping & Instrumentation Diagrams. Use existing spare I/O. Provide resettable flow totalizer. Use spare Analog Input at existing RIO.

Loop No. 150	Storm Flow Retention Basin Level
Monitoring	Refer to Piping & Instrumentation Diagrams. Provide High, and High High Alarms

Loop No. 154	Influent Sampler
Monitoring	Refer to Piping & Instrumentation Diagrams
PCS AUTO	None
PCS MANUAL	Operator may select influent flow pacing source

Loop No. 155	Influent pH and Temperature
Monitoring	Refer to Piping & Instrumentation Diagrams. Provide Low Low, Low, High, and High High alarms.

Loop No. 156	Fine Screens Bypass Gates
Monitoring	Refer to Piping & Instrumentation Diagrams
PCS AUTO	Open on Fine Screens Influent Level (LI-160-1A or LI-160-2A) Hi-Hi Alarm.
PCS MANUAL	Open and close gate

Loop No. 160	Fine Screens
Monitoring	Refer to Piping & Instrumentation Diagrams. Provide high and hi-hi influent level alarms. Provide high and hi-hi differential level alarms.

Loop No. 162	Alternative WAS Flow
Monitoring	Refer to Piping & Instrumentation Diagrams. Provide resettable flow totalizer.

Loop No. 163	Combustible Gas – Fine Screenings Area
Monitoring	Refer to Piping & Instrumentation Diagrams. Provide a “Combustible Gas High” discrete alarm at a threshold level of 20% LEL. Provide a “Combustible Gas High - High” discrete alarm at a threshold level of 50% LEL.

Loop No. 164	Combustible Gas – Fine Screen Building Lower Level
Monitoring	Refer to Piping & Instrumentation Diagrams. Provide a “Combustible Gas High” discrete alarm at a threshold level of 20% LEL. Provide a “Combustible Gas High - High” discrete alarm at a threshold level of 50% LEL.

Loop No. 165	Fine Screens Combustible Gas Alarm
Monitoring	Refer to Piping & Instrumentation Diagrams
PCS AUTO	Activate the horn and light on combustible alarm conditions (Loop 163 or 164).
PCS MANUAL	None

Loop No. 169	Fine Screens Ventilation
Monitoring	Refer to Piping & Instrumentation Diagrams
PCS AUTO	Run at 50% if no occupancy (Loop 176) for 2 hours and low temperature (Loop 166) Otherwise run at 100%
PCS MANUAL	Start/Stop Fan, set speed

Loop No. 260	Primary Sludge Pumps
Monitoring	Refer to Piping & Instrumentation Diagrams.

Loop No. 261	Primary Sludge Recirculation Valve
Monitoring	Refer to Piping & Instrumentation Diagrams.
PCS AUTO	Operator to select Recirculation Mode ON or OFF. While Recirculation Mode is enabled: cycle the valve based on elapsed run time of Raw Sludge Pump to switch discharge locations, it is acceptable to actuate valve while pump is in operation. While Recirculation Mode is disabled: Direct flow to waste (the Sludge Pre-Thickeners).
PCS MANUAL	Set valve position 1 or 2.

Loop No. 263	Primary Sludge Pump Station No.1 Ventilation Alarm
Monitoring	Refer to Piping & Instrumentation Diagrams
PCS AUTO	Activate the horn and light on low ventilation alarm conditions (FSH 262)
PCS MANUAL	None

Loop No. 265	Primary Sludge Discharge Flow Meter
Monitoring	Refer to Piping & Instrumentation Diagrams. Zero flow when no Raw Sludge Pumps are running. Provide a rolling averaged flow that is sampled every 30 seconds over an operator enterable time span (0.0-12.0 hours), provide sufficient significant digits.

Loop No. 270	PEPS Wet Well Monitoring
Monitoring	Refer to Piping & Instrumentation Diagrams. Level: Operate off of the higher of the two wet well levels, maintained for 30 seconds, and provide a disagreement alarm if the two levels differ by more than 6 inches for 15 minutes. Provide Low Low Alarm, Low, High, and High High Alarm. Ammonia and Nitrate: Provide High, and High High Alarms as well as a high rate of change alarm.

Loop No. 275	Primary Effluent Pump Station (PEPS) Pumps
Monitoring	Refer to Piping & Instrumentation Diagrams. Provide alarm if any single pump is requested to start (rising edge) twice within 10 minutes. VFD Ethernet based power monitoring
PCS AUTO	Permissives: Never run three pumps. Associated PEPS Wet Well above Low Low Level for each pump. All IFAS levels (Loop 320) are received/valid (provide an operator disable for this permissive, alarm every two hours if permissive is disabled). IFAS (LI-320/LSHH-320) are below High High Alarm; reset after levels drop below Hi1 for time (4 minutes). Associated pump flow switch is not active (seal water is flowing). Provide a Lead-Lag-Standby pump control matrix to start/stop pumps based on PEPS Wet Well level. Provide PID control to ramp pump speeds together in maintaining common setpoint level in the PEPS wet well. Stagger pumps on or off at the high and low wet well levels respectively. Provide auto failover of a failed pump. Provide auto alternation option to cycle the pump control matrix each time a pump is staggered off, shutting down the current lead pump.
PCS MANUAL	Start or stop pump and set pump speed.
Interlocks	If all three pumps are stopped, stop the two Influent Screen Pumps.

Loop No. 276	Primary Effluent Pump Station No.1 Process Alarm
Monitoring	Refer to Piping & Instrumentation Diagrams
PCS AUTO	Activate the horn and light on common process alarm conditions generated by either of the three PEPS pumps.
PCS MANUAL	None.

Loop No. 280A	PEPS Discharge Flow Meter
Monitoring	Refer to Piping & Instrumentation Diagrams. Zero flow when no PEPS Pumps are running. Calculate Anaerobic Zone No. 1 Flow by subtracting FI-280B. Provide a rolling averaged flow that is sampled every 30 seconds over an operator enterable time span (0.0-12.0 hours), provide sufficient significant digits.
Loop No. 280B	Anaerobic Zones 2 and 3 Influent Flow Meter
Monitoring	Refer to Piping & Instrumentation Diagrams. Zero flow when no PEPS Pumps are running. Calculate Anaerobic Zone No. 2 Flow by subtracting FI-280C.
Loop No. 280C	Anaerobic Zone 3 Influent Flow Meter
Monitoring	Refer to Piping & Instrumentation Diagrams. Zero flow when no PEPS Pumps are running.
Loop No. 281	PEPS Discharge Plug Valves
Monitoring	Refer to Piping & Instrumentation Diagrams. Display a flow imbalance warning if the difference in Flow to Anaerobic Zones 1, 2, or 3, when in auto, differs by more than 20%. Provide a flow imbalance alarm if the Anaerobic Zone 1, Zone 2, and Zone 3 flows (Loop 280) differ by more than 20% for 30 minutes in auto. Provide Plant Screened Influent Flow as a selection of either (= FI-138 + FI-153 + FI-162) or the PEPS effluent flow (Loop 280A)
PCS AUTO 1	Provide 27 calibrated position sets to correspond to the 1 hour averaged value of the selected Plant Screened Influent Flow in the range of 0 – 27 MGD. Display Plant Screened Influent Flow selection, averaged value, and the position sets. Step valve positions to track the averaged flow. Changing step on rising flows at 0.1 MGD averaged flow above step flow and on decreasing flows at 0.1 MGD averaged flow below the step.

PCS AUTO 2	Provide individual limits on minimum and maximum % open for each valve. Provide stepped control of valve position to meet Anaerobic Zone flow balance (Loop 280A less 280B to Zone No.1, 280B less 280C to Zone No.2, and Loop 280C to Zone No.3). Determine the common flow setpoint by the sum of 1 hour averaged Anaerobic Zone flows divided by the number of biological reactors in service. Balance the flows to within a deadband of set point. Valve positions will be changed not more than once every 10 minutes. Deadband to be the smaller of 10% or 1000gpm. Pulse the open or close command to the valve for an individually adjustable number of seconds per percent out of balance the flows are.
PCS MANUAL	Set valve position.

Loop No. 305	IFAS Anaerobic Mixers
Loop No. 306	IFAS AN/AX Zone Mixers
Loop No. 307	IFAS Anoxic Zone Mixers
Monitoring	Refer to Piping & Instrumentation Diagrams.
PCS AUTO	None, by IFAS
PCS MANUAL	None, by IFAS
IFAS AUTO	Permissive: Levels all below LSHH-320 High High Alarm, reset on all levels (LI-320) below Hi1. Run when IFAS train is in service.
IFAS MANUAL	Start/Stop mixer.

Loop No. 308	Anoxic Turbidity
Monitoring	Refer to Piping & Instrumentation Diagrams. Provide Low, High, and High High Notifications

Loop No. 320	IFAS Oxidic Zone Level
Monitoring	Refer to Piping & Instrumentation Diagrams, Continuous monitoring. Provide Low, Hi1, Hi2, Hi3 and High High Alarms. High High is generated from either the level transmitter as well as the LSHH.

Loop No. 325	IFAS Oxid Internal Recycle (IR) Pumps
Monitoring	Refer to Piping & Instrumentation Diagrams. VFD Ethernet based power monitoring Provide an alarm if the IFAS forward flow per train (Anaerobic Zone flow plus associated FI-328) exceeds the IFAS maximum recommended flow per train.
PCS AUTO	Permissives: - Below associated level (LI-320) Hi3 alarm; reset by a level below Hi1 and RAS Pump Permissive satisfied for time (5 minutes). Provide Lead-Standby pump control to run a pump while the IFAS train is in service and pace a common IR flow rate target. The total IR flow target is equal to XXX% (operator enterable) of the averaged PEPS Discharge Flow (FI-280A). This is then divided by the number of IR Pumps for IFAS trains in service; note that 2 IR pumps are assumed for each IFAS train in service without regard to if those pumps are running or have been reduced by levels, to get the target flow per IR pump. Setpoint reduction: Provide notification if flow is reduced. Flow control not to exceed an operator enterable IFAS flow limit (26.6 MGD/3 $\approx$ 6150gpm) = (FI-280A+(Sum of FI-328-1, 2, and 3))/(number of IFAS trains in service). - If the forward flow (FI-380A+(sum of FI-328))/(number of IFAS trains in service) exceeds the IFAS maximum flow limit per train (6150 gpm, to be confirmed prior to startup), reduce the IR flow setpoint so as not to exceed that limit. - Above Hi2 level (LI-320) the IR flow setpoint to the Effluent IR Pump will be reduced by a percentage equal to the percentage of current level between Hi2 and Hi3, such that at Hi3 Alarm the flow Setpoint is reduced by 100%. The flow feedback for these pumps is provided by FI-328 minus FI-327.
PCS MANUAL	Start or stop pump and set pump speed.
IFAS AUTO	None
IFAS MANUAL	None

Loop No. 326	IFAS Effluent Channel Internal Recycle (IR) Pumps
Monitoring	Refer to Piping & Instrumentation Diagrams. Display both the operator entered setpoint as well as the actual % currently being used to calculate the RAS Flow Setpoint. Display this value in yellow when being reduced. VFD Ethernet based power monitoring
PCS AUTO	Permissives: below associated level (LI-320) Hi2 alarm; reset by a level below Hi1 and Oxid IR permissives satisfied (Loop 325) for time (15 minutes). Run while the IFAS train is in service and pace a common IR flow rate target. This IR flow target is described under Loop 325 with flow feedback from FI-327. Above Hi1 level the IR flow setpoint to the Effluent IR Pump will be reduced by a percentage equal to the percentage of Level between Hi1 and Hi2 Alarm, such that at Hi2 Alarm the Flow Setpoint is reduced by 100%.
PCS MANUAL	Start or stop pump and set pump speed.
IFAS AUTO	None
IFAS MANUAL	None

Loop No. 327	IFAS Effluent Channel Internal Recycle Flow
Loop No. 328	IFAS Internal Recycle Flow
Monitoring	Refer to Piping & Instrumentation Diagrams.

Loop No. 350	IFAS Blowers
Monitoring	Refer to Piping & Instrumentation Diagrams VFD Ethernet based power monitoring
PCS AUTO	None, By Blower Control Panel (BCP)
PCS MANUAL	None, By Blower Control Panel (BCP)
BCP AUTO	Enabled by discharge pressure below High High Alarm, operator resettable. Start/Stop and pace blowers to maintain a pressure setpoint in the IFAS discharge header. Combine with Diurnal Blowers (Loop 355) to provide Lead-Lag1-Lag2-Lag3-Lag4-Lag5 blower selection matrix. Provide automatic failover.

Loop No. 351	IFAS Air Header Pressure
Monitoring	Refer to Piping & Instrumentation Diagrams. Utilize the higher of the two values and provide a disagreement alarm if the measurements differ by 3.0 psi for 10 minutes. Provide Low Low, Low, High, and High High Alarms

Loop No. 355	IFAS (Diurnal) Blowers
Monitoring	Refer to Piping & Instrumentation Diagrams VFD Ethernet based power monitoring
PCS AUTO 1	Paced proportionally to LI-140 with 2 point operator enterable level and VFD speed correlation for pacing slope determination.

PCS AUTO 2	Enabled by discharge pressure below High High Alarm. Start/Stop and pace blowers to maintain a pressure setpoint in the IFAS discharge header. Combine with IFAS Blowers (Loop 350) to provide Lead-Lag1-Lag2-Lag3-Lag4-Lag5 blower selection matrix. Provide automatic failover.
PCS MANUAL	Start or Stop Blower and adjust blower speed setpoint while IFAS DO levels, header pressure, and header temperature are viewable.

Loop No. 375	IFAS Aeration Flow Control Valve
Monitoring	Refer to Piping & Instrumentation Diagrams.
PCS AUTO	None, by IFAS
PCS MANUAL	None, by IFAS
IFAS AUTO1	Step position periodically to maintain operator setpoint air flow (FI-376) within minimum and maximum valve position limits.
IFAS AUTO2	Cascade Dissolved Oxygen Level (AI-380) setpoint control into an air flow (FI-376) setpoint control with minimum and maximum flow limits to step position periodically within minimum and maximum valve position limits which may need to be set individually for each valve.
IFAS MANUAL	Set valve position

Loop No. 376	IFAS Train (1,2,3) Air Flow
Monitoring	Refer to Piping & Instrumentation Diagrams. Continuous air flow monitoring. Separately display total IFAS air flow in SCFM.

Loop No. 377	IFAS Deoxic Zone Flow Control Valve
Monitoring	Refer to Piping & Instrumentation Diagrams.
PCS AUTO	None, by IFAS
PCS MANUAL	None, by IFAS
IFAS AUTO	None
IFAS MANUAL	Set valve position

Loop No. 380	IFAS Train (1,2,3) Dissolved Oxygen
Monitoring	Refer to Piping & Instrumentation Diagrams.

Loop No. 390	IFAS Air Scour Blowers No. 1 & 2
Monitoring	Refer to Piping & Instrumentation Diagrams, Continuous monitoring.
PCS AUTO	None, by IFAS
PCS MANUAL	None, by IFAS
IFAS AUTO	Periodically operate to blow accumulation off of the IFAS cylindrical screens.
IFAS MANUAL	Start or Stop Blower while IFAS Air Scour Control Valve (Loop 395) statuses are viewable.

Loop No. 395	IFAS Air Scour Control Valve
Monitoring	Refer to Piping & Instrumentation Diagrams.
PCS AUTO	None, by IFAS
PCS MANUAL	None, by IFAS
IFAS AUTO	Periodically operate in conjunction with Air Scour Blowers (Loop 390) to blow accumulation off of the IFAS cylindrical screens.
IFAS MANUAL	Open or close valves.

Loop No. 450	Filtration Ortho Phosphorus
Monitoring	Refer to Piping & Instrumentation Diagrams. Provide High and High High Alarms.

Loop No. 460	Tertiary Filters
Monitoring	Refer to Piping & Instrumentation Diagrams.
PCS AUTO	None
PCS MANUAL	None

Loop No. 500	Scum Well Level
Monitoring	Refer to Piping & Instrumentation Diagrams, Continuous monitoring. Provide Low Low and High High Alarms

Loop No. 501	Rotating Scum Pipe
Monitoring	Refer to Piping & Instrumentation Diagrams

Loop No. 505	Scum Pumps
Monitoring	Refer to Piping & Instrumentation Diagrams

Loop No. 506	Scum Spray
Monitoring	None

Loop No. 510	Secondary Clarifier Sludge Flow
Monitoring	Refer to Piping & Instrumentation Diagrams, Continuous monitoring.

Loop No. 515	Return Activated Sludge (RAS) Pumps
Monitoring	Refer to Piping & Instrumentation Diagrams. Display both the operator entered setpoint as well as the actual % currently being used to calculate the RAS Flow Setpoint. Display this value in yellow when being reduced as well as the reason. VFD Ethernet based power monitoring
PCS AUTO	Permissive: RAS Wet Well Level (LI-511) above low level, reset after time (5 minutes). All IFAS levels (LI-320/LSHH-320) below High High Alarm, reset after all levels drop below Hi1 for time (1 minute). Provide a Lead-Lag-Standby pump control matrix to start/stop pumps based on requested RAS flow. Stagger Pumps on and off, ramping pump speeds together to maintain a total RAS flow (sum FI-519's) equal to XXX% (operator enterable) of the averaged PEPS Effluent Flow (FI-280A). If the highest of the IFAS Levels (LI-320's) exceeds Hi3 the total RAS flow setpoint will be reduced by a percentage equal to the percentage of Level between Hi3 and High High Alarm, such that at High High Alarm the RAS Flow Setpoint is reduced by 100%.
PCS MANUAL	Start and stop selected pump, set speed.

Loop No. 519	Return Activated Sludge (RAS) Flow
Monitoring	Refer to Piping & Instrumentation Diagrams, Continuous monitoring, Sum flows to provide total RAS flow.

Loop No. 525	Waste Activated Sludge (WAS) Pumps
Monitoring	Refer to Piping & Instrumentation Diagrams, Continuous monitoring, display repeat cycle timers. VFD Ethernet based power monitoring
PCS AUTO 1	Pump operation will be enabled by a minimum level in the RAS Wet Well. Provide pump control to maintain flow set point at either FI-527 or FI-530 (531-1 + 531-2) (selectable).
PCS AUTO 2	Pump operation will be enabled by a minimum level in the RAS Wet Well. Display repeat cycle timers. Provide Lead-Standby control to Provide pumps with a repeat cycle timer control including a common PCS manual control of pump speed. Provide operator enterable set points for on and off time periods as well as an auto alternation selection.
PCS MANUAL	Start and stop selected pump, set speed.

Loop No. 526	Waste Activated Sludge (WAS) Bleed Valve
Monitoring	Refer to Piping & Instrumentation Diagrams
PCS AUTO	Modulate valve to maintain operator setpoint flow at FI-527.
PCS MANUAL	Set valve position.

Loop No. 531	RAS to Pre-Thickener Flow Meter
Monitoring	Refer to Piping & Instrumentation Diagrams. Continuous monitoring, Sum flows to provide total Pre-Thickener RAS flow (FI-530). Zero flow when no Raw Sludge Pumps are running.

Loop No. 533	WAS to Pre-Thickener Flow Meter
Monitoring	Refer to Piping & Instrumentation Diagrams. Continuous monitoring, Sum flows to provide total Pre-Thickener WAS flow (FI-532). Zero flow when no Waste Pumps are running.

Loop No. 901	Digester Heat Boiler
Monitoring	No P&ID; Continuous monitoring for “Trouble” and “Fault” alarms from Building Management System controller in Solids Handling Building, RIO Unit 1.

Loop No. 902	Building Heat Boiler
Monitoring	No P&ID; No P&ID; Continuous monitoring for “Trouble” and “Fault” alarms from Building Management System controller in Solids Handling Building, RIO Unit 1.

3.5 STARTUP

- A. The CSI shall provide the services of the PCS programmer during the “de-bugging” and commissioning phases of startup. Changes to the PCS application that may be required for changes in the control or equipment encountered in the field during construction and startup shall be completed at no additional cost.
- B. Factory Acceptance Test Control System Logic Demonstration as called for in the Supplementary Provisions shall include a simulated I/O check of the control panels and OIT’s.
- C. Prior to the commissioning of all new equipment, the CSI shall perform a “Field Acceptance Test” in the presence of the Engineer and the Owner, using reviewed and approved IQ/OQ (Installation Quality / Operation Quality) testing procedures and documentation. Each field device and instrument must be successfully checked out through the HMI screens for proper operation, control, and status.
 1. All PCS HMI networking, communications, and functionality shall be checked, tested, verified, and made fully functional and operational by the CSI.
 2. The CSI shall provide the necessary test equipment and qualified test personnel.
 3. Process Control System Point-to-Point Wiring Continuity Test and Checkout as called for in the Supplementary Provisions shall include the presentation of the signed coordination drawings as specified in Division 40 Section “Control System Integrator”.
 4. Final point-to-point verification as called for in the Supplementary Provisions shall include a demonstration of all SCADA I/O points and PCS Manual Controls as described under Startup above and a test of PCS Manual functionalities.

- D. Plant Integrated I/O Testing as called for and specified in the Supplementary Provisions shall include a demonstration of SCADA I/O, remote PCS Manual control, and PCS Auto control functionalities as described herein.
- E. Test Results
 - 1. In the event of failure of the field test, the CSI shall perform the necessary corrections and retest, at his own expense, until approved/accepted by Owner.
 - 2. Final acceptance will be dependent upon the satisfactory operation and performance after installation.

3.6 TESTING

- A. During the Plant Startup Performance Period as described in the Supplementary Provisions the PCS shall begin a separate 30-day continuous operation test. The PCS performance period shall begin with a complete PCS system cold startup, coordinated to begin at a time agreeable to the owner. If for any reason the PCS is unusable or unsatisfactory during this 30 days of continuous operation, after initial startup, the CSI shall have 30 minutes to resolve the issue. If the issue is unresolved after 30 minutes the 30 day test shall restart.

3.7 DEMONSTRATION AND TRAINING

- A. Provide training to the plant staff to adjust, operate, and maintain the equipment.
 - 1. See Section 01 79 00 – “Demonstration and Training”
- B. The CSI is responsible for the training of Owner selected personnel on the entire PCS. The CSI shall prepare and submit a written training outline to the Engineer for approval. When approved, the CSI must provide at least a 2-week advance notice of training.
 - 1. The training shall consist of four (4) identical training sessions held on site, weekdays only, between the hours of 7:30 a.m. and 4:30 p.m. (the duration of each session shall be eight hours of training with one hour for lunch). Training shall include details on using, modifying, troubleshooting, and servicing all hardware and software.
 - 2. The training shall include both formal classroom lectures and “hands-on” training on the actual system, stepping through the features of the system, networks, and programming software. Review data in Operation and Maintenance manuals with plant staff.
 - 3. The CSI shall provide all hardware, software, and accessories necessary for training.
 - 4. Training activities shall be permitted during the Plant Startup Performance Period as described in the Supplementary Provisions.
- C. The CSI shall provide an on-site presence Monday-Friday, 7:30 a.m. to 4:30 p.m. (one hour for lunch), for 4 weeks to aid in transitioning plant personnel to the use of the new PCS and to debug the system. During this time the CSI personnel shall work with and guide plant personnel through the automated operation of the plant.

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SECTION 40 96 00

CONTROL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

- A. This Section includes specific requirements for the Process Control System (PCS) Cabinets as shown on the Drawings and specified herein.

1.3 RELATED WORK

- A. Division 26 Section "Electrical Controls and Relays" for additional enclosure and component requirements.
- B. Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding requirements.
- C. Division 26 Section "Data Highway Cables" for fiber optics requirements.
- D. Division 40 Section "Instrumentation General" for common requirements that apply here.
- E. Division 40 Section "Programmable Controllers" for PLC and OIT requirements.
- F. Division 40 Section "Control Systems Integrator" for Factory Acceptance Testing.
- G. Refer to Contract Drawings for Inputs and Outputs.

1.4 QUALITY ASSURANCE

- A. The cabinet and control panel manufacturer shall have quality certification to ISO 9000:2000, or an equivalent quality management system acceptable to the Engineer.
- B. The cabinet and control panel manufacturer shall be capable of obtaining UL508A listing and labeling for the equipment furnished under this Contract.

1.5 SUBMITTALS

- A. Submittals shall be provided as required by the General Conditions, Division 1, and Division 40 Sections "Instrumentation General".

- B. Submittals shall contain:
 - 1. Panel cut-out location and sizes
 - 2. Back panel instrument location
 - 3. Electrical point-to-point wiring diagrams to show detail internal wiring and outgoing wiring to field devices. Device tag numbers and descriptions shall be used where shown on the Contract Drawings or identified in the Contract Documents.
 - 4. Heat gain calculations showing adequate cooling capacity.
 - 5. Power requirement calculations for dc power supplies and UPS
 - 6. Nameplate Schedule
 - 7. NEMA type designation and manufacturer data describing the enclosure and showing its compliance with specifications and associated standards.
- C. Samples of any material shall be submitted upon Engineer's request.
- D. Factory Acceptance Test results

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide an acceptable environment for all enclosed equipment, utilizing cooling and heating devices, humidity control, and power conditioners as needed.
- B. Surge protection: Power and signal wiring of all equipment located outside of buildings and inline equipment (magnetic flow meters) shall be protected with surge arresting devices.

2.2 CONTROL PANELS

- A. The following control panels shall be provided as shown on the Drawings and specified herein:
 - 1. PCS Cabinets
 - 2. RAS Level Relay Cabinet
 - 3. Scum Pump Control Panels
 - 4. Influent Channel Air Flow Controller
- B. PCS Cabinets shall conform to the following unless otherwise indicated:
 - 1. Totally enclosed NEMA 12 freestanding floor-mounted cabinet of not larger than a 30" deep base to allow passage through a standard doorway unless specifically coordinated for delivery to a given installation location.
 - 2. Continuous piano-style door hinge(s) with removable pin.
 - 3. Provided with engraved nameplates having black lettering on a white background shall be provided and have a minimum width of 1/2 inch. Lettering shall be in capitals except as shown. Lettering shall be as shown or scheduled

4. Operator Interface Terminals shall be provided as indicated on the Drawings.
5. PCS Cabinets shall include:
 - a. Door-operated light switch and LED lamp(s) complete with safety shield(s).
 - b. Large print pockets mounted to the interior face of the door.
 - c. 120 Vac, 15 ampere GFI utility outlet (non-UPS backed).
 - d. Two single-pole 15 ampere, 120 Vac, circuit breakers. One for UPS backed power and one for utility power.
 - e. Additional temperature conditioning devices shall be provided if necessary to keep the ambient temperature inside the panel within the acceptable operating temperature range of ALL internally housed components.
 - f. Terminal blocks - located in the bottom of the rear panel or on side panels as required. Minimum spacing between terminal blocks shall be 1 inch and a minimum of 1.5 inches all around. Duplicate terminals shall be used to limit the number of wires at one terminal to two. 25% spare terminals shall be provided.
 - g. Uninterruptible Power Supply (UPS) for each PLC/OIT as shown on the Contract drawings.
 - 1) Each UPS shall maintain power for at least 30 minutes under full-load. Utility lights, utility receptacles, and motors are excluded.
 - 2) Input power shall be 120VAC, 60Hz.
 - 3) UPS shall be mounted in such a way as to allow replacement without significant disruption to the other components or wiring within the enclosure.
 - 4) Minimum size shall be 1000 VA.
 - 5) UPS shall be true "on-line", line-interactive, double-inverting units, non-switching with true sine-wave output.
 - 6) Provide a minimum of 2 discrete outputs to the PLC to monitor: supply power status and battery health. All status relays shall be wired to PCS inputs for status monitoring and alarming on the PCS system.
 - 7) Acceptable UPS manufacturers are: APC, Liebert, Powerware, or approved Equal.
 - h. 24-Volt DC Power Supply
 - 1) Shall be adequately sized to provide power to field instruments and cabinet components as required with an additional 50% spare capacity.
 - 2) All DC power supplies shall be linear (not switching) with integral voltage regulator.

- i. Ethernet Switch (Quantity and ports as shown on the Drawings at a minimum)
 - 1) Shall support 10/100Base-T (RJ-45) and 1000BaseFX connections as shown on contract drawings at a minimum.
 - 2) Shall support Ethernet self-healing ring topology over the fiber optic links. Ring shall reroute traffic within 300 ms of a failure.
 - 3) Shall provide a relay output for alarm in the event of a communications failure.
 - 4) Switches shall support plug-and-play, auto-sensing, MDI-MDIX uplink port to connect to other devices, Half/Full-duplex mode, automatic speed negotiations, bandwidth management, and port mirroring.
 - 5) Shall be ruggedized provided with a DIN-rail mountable enclosure.
 - 6) Acceptable Ethernet Switch Manufacturers are: Rockwell/Cisco Stratix 8000, Hirschmann, MOXA, N-Tron, Weed Instruments, Phoenix Contact, Allied Telesyn, Sixnet, or approved Equal.
 - j. Fiber Optic Patch Panels (as required)
 - 1) DIN rail mounted fiber optic enclosures shall provide for proper bend radius via internal cable management and secure terminations within an industrial environment.
 - 2) All fiber strands of each cable shall be terminated in a proper fiber optic patch panel.
 - 3) Adapter plates to be provide for connections as required
 - 4) With approval Fiber Patch Panels may be located on the outside of a PCS Cabinet, or adjacent to a PCS Cabinet, space permitting as coordinated in the field to save space within the PCS Cabinets.
- C. RAS Level Relay Cabinet
- 1. Shall be NEMA 12 type minimum type enclosure with nameplate.
 - 2. Shall contain a Timer-Off-Delay relay with 120Vac coil and a minimum of 6 normally open contacts rated for not less than 100VA.
 - 3. Shall have green indicating light on the face.
- D. Scum Pump Control Panels
- 1. Shall be NEMA 4X mounted to stainless steel channel off the exterior of the railings or concrete structure so as not to impede working space on the platform.
 - 2. Shall provide power and local control for the scum pump and dip tube as shown on the Drawings.
- E. Influent Channel Air Flow Controller
- 1. Shall be NEMA 4X and provided with a weather cover, separated from the enclosure by one inch.
 - 2. Provided with an equipment mounting rack.
 - 3. Shall control the influent gates to limit air flow into the odor control of the headworks as shown on the Drawings.
 - 4. Process controller: Single Loop
 - a. NEMA 4X

- b. Shall operate on 120Vac, 1 phase, 60 Hz.
- c. Shall accept a 4-20 mA process signal
- d. Shall support proportional control to produce a 4-20 mA signal that is either directly or inversely proportional to the input.
- e. Shall have an operational temperature range of not less than 32-131 degrees F.
- f. Shall be ABB ControlMaster CM30, or approved equal.

2.3 MISCELLANEOUS NETWORKING HARDWARE

- A. Provide and install all necessary networking hardware (cables, boxes, cabinets, tees, taps, terminators, drop cables, connectors, converters, etc.).
- B. Administrative network cables shall be blue and control network cables shall be orange.

2.4 SPARE PARTS

- A. Provide the following spare parts, packaged in their original unopened boxes, for use by the Owner.
 - 1. 2 – power supplies of each type supplied (current loops, device power)
 - 2. 1 – UPS of each type supplied
 - 3. 6 – Intrinsic safety barriers of each type supplied
 - 4. 5% spare relays of each type used
 - 5. 25% spare fuses of each type used

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Perform factory acceptance testing of each control panel prior to shipment to the site.
- B. Electrical Contractor shall verify placement of panel prior to fabrication and any and all shipping splits shall be provided.
- C. All panel wiring shall be installed by the panel manufacturer and shall be brought out to identified terminal blocks. Interwiring between panels shall be from terminal blocks to terminal blocks. Terminal blocks for panel wiring shall be correlated with those for the electrical equipment by the panel manufacturer.
- D. Panels shall be grounded and all equipment and circuits included in the panels, as shown or required to be grounded, shall be connected to the grounding conductors.
- E. The panels shall be installed as shown and directed. All wiring shall enter the panels as shown or specified. Penetrations shall not be permitted in the top surface of Control Panels. If a top surface entrance is required obtain written a written exemption from the Engineer for each conduit. These conduits will at a minimum be sealed to prevent moisture from falling into the enclosure.

- F. The panels shall be checked and all necessary adjustments shall be made in the field after installation, by representatives of the manufacturers of the equipment included in the panel.
- G. AC and DC wiring is to be separated to the extent possible within panels.

3.2 POWER LINE SURGE PROTECTORS

- A. Install power line surge protectors on the incoming power of all equipment susceptible to damage in an industrial or commercial environment due to line surges, lightning, transients, or other line disturbances.
- B. Individual equipment with adequate integral line surge protection is not required to have additional protection, although the Contractor is cautioned that some integral surge protection is not adequate for an industrial environment.
- C. All control panels containing electronic, microprocessor based, or other line powered equipment susceptible to damage shall be provided with adequate line surge and transient protection.

3.3 DEMONSTRATION AND TRAINING

- A. Provide training to the plant staff to adjust, operate, and maintain the equipment.
 - 1. See Section 01 79 00 – “Demonstration and Training”
 - 2. Train Owner's maintenance personnel for a minimum of 4 hours on procedures and schedules for energizing and de-energizing, troubleshooting, servicing, and maintaining equipment.
 - 3. Review data in Operation and Maintenance manuals with plant staff.
 - 4. Schedule training with Owner, with at least 14 days advance notice.

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SECTION 40 98 00

CONTROL SYSTEMS INTEGRATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the requirements for the Contractor to obtain the services of an instrumentation and controls subcontractor.
 - 1. This subcontractor is referred to as the Control Systems Integrator (CSI).
- B. The CSI shall be responsible for the design, coordination, and integration of the instrumentation and control systems. The CSI shall have total responsibility for the design, fabrication, configuration, programming, testing, start-up, and implementation of the Process Control System (PCS), PCS cabinets, instrumentation configuration, and designated control panels as specified herein.
 - 1. The CSI shall meet with the owner to arrange and coordinate work efforts as described herein.
 - 2. The CSI shall supply, configure, and commission all instrumentation, instrumentation equipment, and components not supplied by equipment vendors (as shown on the drawings).
 - a. Vendor-supplied instrumentation equipment and components, VFCs, motor starters/controllers, valve actuators, and other process control and monitoring equipment shall be configured by the individual Vendors in accordance with the Specification. Wiring from PCS Cabinets to process control and monitoring equipment shall be in conformance with the Loop Diagrams supplied by the CSI.
 - b. CSI shall coordinate with the specific vendors to provide a seamless communications between systems and allow for full monitoring and control from SCADA systems.

1.3 RELATED WORK

- A. Division 26 Section "Electrical Controls and Relays"
- B. Division 40 Section "Instrumentation General"
- C. Division 40 Section "Programmable Controllers"
- D. Division 40 Section "Process Control System"
- E. Division 40 Section "Control Panels"

1.4 CODES AND STANDARDS

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. ANSI - American National Standards Institute
 - 2. ASME - The American Society of Mechanical Engineers
 - 3. ASTM - The American Society for Testing Materials
 - 4. NEMA - National Electric Manufacturers Association
 - 5. UL - Underwriters Laboratories, Inc.
 - 6. ISA - Instrument Society of America
 - 7. IEEE - Institute of Electrical and Electronic Engineers
 - 8. NEC - National Electrical Code

1.5 QUALITY ASSURANCE

- A. The CSI shall be regularly engaged in the business of instrumentation and controls and shall be responsible for the furnishing, coordination, and installation of the equipment specified herein.
- B. The CSI shall demonstrate the requisite resources of in-house staff, facilities and finances to complete the project in the schedule specified. These resources shall include personnel who are direct payroll employees of the CSI to engineer, design, implement, fabricate, stage, and test the entire integrated hardware and software system at the CSI's facilities. In-house personnel shall include all disciplines associated with system manufacture, fabrication, and integration to include but not be limited to engineering, drafting, analog and digital control systems and wiring design, construction, wiring, labeling, software configuration, programming, project management, quality control, field engineering and training.
- C. The CSI shall assign a qualified person to be the CSI Project Manager for this project. The Project Manager shall be a direct employee of the CSI, shall be assigned to this specific project, and shall be skilled and experienced in project management, and in the type of work described herein. The Project Manager shall be assigned for the duration of the Contract. Should it become necessary to replace the CSI project manager, the Contractor shall submit to the Engineer the credentials of the qualified person assigned as a replacement.
- D. The CSI shall maintain a UL 508 and 508A fabrication shop located at the CSI facility for the manufacturing of control panels, cabinets, consoles, instrument racks, enclosures, and wiring required for this project. This shop shall be available for inspection by the Engineer to observe quality control and workmanship. The CSI facilities shall include hardware and software owned by the CSI Subcontractor for development and support of any system software, and any testing and demonstration equipment to be utilized on the project.
- E. The CSI shall provide an onsite presence for the length of time necessary for system installation, start-up, and commissioning of the PCS.
- F. The following firms are likely candidates understood by the Engineer to meet the qualifications and requirements for a CSI identified herein. (listed in alphabetical order):
 - 1. The below list is being provided only as courtesy to the Contractor. Qualifications of the proposed CSI shall be submitted regardless if they are

listed herein or not. Qualifications shall be submitted in accordance with the submittal requirements of this specification section as well as those contained in the General Provisions. It shall be the responsibility of the Contractor to verify that the proposed CSI meets the requirements of the Contract Documents.

- a. Advanced Integration Group inc. McKees Rocks PA
 - b. Hilscher-Clarke, Canton OH
 - c. Pro-Tech, Akron OH
 - d. Rovisys, Aurora OH
 - e. or approved equal
- G. In an effort to obtain current products and avoid installation of obsolete equipment during construction the CSI is encouraged to submit current technologies while noting any minor discrepancies from the specified requirements.

1.6 SUBMITTALS

- A. Submittals shall be in accordance with the General Conditions, Division 1, and Division 40 Section "Instrumentation General".
- B. Submit a CSI qualifications package for the proposed CSI for this project. The qualifications package shall include the following information which shall be organized and formatted as follows:
 - 1. Company Background - Provide a brief company overview detailing CSI's experience, capabilities, and available resources. Description of available resources shall include labor categories, staffing, equipment, material availability, testing equipment, and training staff and aids.
 - 2. Experience in Water/Wastewater Applications - Provide a list and detailed description of recent (last 7 years) projects that the CSI has successfully performed. Each project shall be provided with the project duration and date of completion. At the Engineers discretion, the CSI may be required to provide as-built project documentation for complete system integration service experience for a minimum of three completed projects comparable in size, scope, and complexity.
 - 3. Project Personnel Plan - Provide a brief project task list detailing the personnel to be utilized for engineering and design, fabrication, installation, startup, demonstration, and training for this project. Include personnel resumes for all personnel which will be performing services for this project. Provide name and resume for the proposed project manager for this project.
 - 4. Quality Assurance Plan - Provide a brief summary of the CSI's in-place quality assurance plans for performing work from engineering through startup and training.
 - 5. Facilities and Equipment - Provide a detailed list of office and fabrication space, location where fabrication of panels will take place, and available meeting facilities. List numbers and types of Computer Aided Drafting software and OITs that are available for this project.
 - 6. Maintenance – The CSI shall respond to a maintenance call within 4 hours, providing onsite normal maintenance services within 24 hours following a

maintenance request, and emergency service within eight hours following an emergency service request. Maintenance call issues shall be resolved within 7 days. Normal and emergency maintenance service shall be made available 24 hours every day on a call basis for the warranty period. A point of contact and telephone number(s) shall be provided.

7. Reference Letters - Provide a minimum of five reference letters summarizing the CSI's performance on similar projects. Reference letters shall be from Contractors or Owners that have had contractual relationships with the CSI on specific projects.

C. Project Plan:

1. After the CSI Qualifications Package has been accepted provide a complete plan describing the development of the Process Control System, complete with submittal and procurement schedule, progress meeting topics and dates, testing and delivery dates, project milestones.
2. Provide preliminary Coordination Drawings to include Loop Drawings for CSI scope of work coordinated with the contract requirements, existing "As Built" documentation, and existing PLC programs.
 - a. Loop Diagrams shall be marked "For Construction Coordination"
 - b. Each sheet shall include signature and date prompt for electrical field testing: "This document has been marked up to reflect "As Built" conditions." This is to be signed by an authorized representative of the company performing wire terminations during the Intermediate Point-to-Point I/O Check.
 - c. Each sheet shall include signature and date prompt for functional field demonstration. "System demonstrated automated functionality." This is to be signed by an authorized representative of the Owner during the Final Point-to-Point I/O check.
3. Provide an acknowledgement that additional coordination with equipment manufacturer submittals is required and will be provided. The CSI shall obtain certain specific submittal information pertaining to control equipment required to be furnished by equipment manufacturers. This information may include catalog data, field specific wiring diagrams, and shop drawings. Note that any Control panel shop drawings submitted prior to coordination with the approved shop drawings for the specific controls are at the direct risk of the CSI. Therefore, it is the responsibility of the Contractor, the CSI, and the specific manufacturers of equipment to coordinate the submittals for new equipment.
4. If deviations to the Contract Documents are proposed, the CSI shall include a detailed description and explanation for each proposed deviation to the Contract Documents.
5. All other Division 40 9X XX submittals will be returned without review until the Project Plan has been submitted and approved.

D. CSI Meetings:

1. Initial Coordination Meeting: The CSI shall be responsible for scheduling and holding an initial coordination meeting with the Owner, General

Contractor, Electrical Contractor, and the Engineer to review the scope and schedule of the project. Meeting shall be scheduled after all process equipment has been approved. This meeting shall be attended by the CSI project manager, IC engineer and all other parties that shall be involved in the integration of the Process Control System (PCS).

2. Progress Meetings - The CSI shall be responsible for holding progress meetings during the course of the project to coordinate integration requirements with the Contractors. The CSI shall hold a minimum of six (6) progress meetings at the project site. The progress meetings shall be held at an agreeable time for the Owner, General Contractor, Electrical Contractor, and the IC Engineer. Additional meetings and or conference calls shall take place as required to coordinate the Work.
 3. Agenda and supporting documents to be sent out prior to meetings
 4. Meeting Minutes: Provide for approval an attendance list, outline of discussion points, and record of any clarifications, decisions, or potential non-conformities to the contract that may have been agreed to following each CSI Coordination Meeting.
- E. Preconstruction coordination drawings shall be prepared by the CSI and shall include the following, as a minimum:
1. System block, one-line, riser diagrams
 2. Loop Diagrams
 - a. A complete set of Instrument Loop Diagrams prepared in conformance with ISA-5.4-1991 with 5.2 Minimum Content Requirements and 5.3 Optional Content Information, showing all PCS components and wiring, as well as software addresses and communications links for those systems modified under this contract.
 - b. Interconnection wiring diagrams showing control panel and field wiring to components, regardless of whether or not the components are furnished by the CSI for panels and field devices furnished under this Contract.
 - c. Indication of field wiring to components shall include terminations in intermediate terminal boxes, field devices and instrumentation, control panels and equipment including chemical feed pumps. Diagrams shall include terminal numbers for all new terminations to equipment. These drawings shall be signed during testing by the authorized person supervising the test.
 3. Control panel submittals for panels furnished or fabricated by the CSI as described in Division 40 Section "Control Panels".
- F. Pre-installation Factory Test Schedule and Report
1. Submit a testing schedule and test report for factory testing of panels and associated PLC programming, OIT programming and OIT graphics programming. The schedule shall list the location of panel fabrication, the location that the test will be conducted at, and the date the test will be

conducted. Schedule shall be submitted a minimum of 4 weeks prior to conducting actual testing. Where revisions to the dates contained in the schedule become necessary, the CSI shall submit revised dates a minimum of seven calendar days prior to conducting actual tests in order to allow the Owner time to plan for witnessing the test. All tests shall be subject to observation by the Owner or designated representative. Factory testing is described in Part 2 of this specification section.

2. A panel factory test report shall be submitted for each panel furnished by the CSI. Test report shall include date and time of test, personnel conducting test, personnel witnessing test, name of panel and fabricator, location of test, test equipment utilized, and a detailed description of the actual tests performed.

G. Field Testing and Demonstration Plan

1. Submit a testing and demonstration plan for the equipment and instrumentation that is furnished by the CSI. The plan shall consist of two main components, 1) testing and 2) demonstration. Both testing and demonstration shall include individual field devices, individual pieces of equipment, and systems.
2. Testing and demonstration of the components, equipment and systems shall include details of staff to be used, testing equipment to be used, listing of equipment and systems to be tested, and a detailed description for testing. Testing shall include final testing of calibrated ranges and actuation settings of instrumentation and field devices, testing of panel mounted controls and control stations, and testing of interlocks, status indication and alarms between panels and systems.
3. The demonstration plan shall be similar to the testing plan in that the same tests shall be performed for the demonstration as were performed during testing, for the purposes of demonstrating the operation of the individual pieces of equipment, instrumentation and systems. It shall also serve the purposes of completing a final checkout of the systems. The Contractor shall notify the Owner in writing a minimum of seven (7) calendar days prior to performing demonstration of equipment or systems.
4. The CSI is to make a reasonable effort to coordinate a means of physically testing each aspect of the control system. Any process scenarios that are not permissible and not reasonably able to be triggered may be forced in the logic.
5. Requirements for testing and demonstration of operation of equipment described herein shall incorporate the requirements for testing and demonstration as specified in other Division 40 9X XX Sections.
6. Plan shall include CSI's participation in the complete system testing.

- H. Training Plan – Provide a plan for training the Owner's personnel in the use, function, and operation of new or modified panels and control systems. Training plan shall include equipment to be covered by the training, description of the training to be provided, training aids and materials to be provided, duration of each training session, and proposed schedule for training. Note that dates and times are to be coordinated with the Owner. Training plan shall incorporate the training

requirements outlined in the other Division 40 9X XX Sections.

- I. Closeout Record Drawings
 - 1. Record Drawings shall be submitted with the required number of sets of prints. Prints shall be full sized. Once the record drawings are reviewed by the Engineer, the CSI shall incorporate the Engineer's comments, submit required number of sets, and submit two copies of the electronic files on compact disks. Files shall be formatted in AutoCAD DWG. A list of drawing files with corresponding drawing titles shall be provided with the disks. Record Drawings shall be provided after conditional acceptance of the facility is approved and shall include all field changes and design modifications made during construction.
- J. Operation & Maintenance (O&M) Manuals
 - 1. The CSI shall provide Operations and Maintenance (O&M) Manuals as specified in each of the following individual equipment specifications:
 - a. Field Instruments
 - b. Programmable Logic Controllers
 - c. Process Control System (PCS)
 - d. Control Panels
 - 2. Operations and Maintenance Manuals shall be in accordance with Division
- K. Training Certificate – Provide times, dates, and descriptions of training provided along with an attendance list.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The CSI shall furnish equipment, programming, labor, materials and appurtenances in accordance with the requirements of technical specifications listed in Division 40 9X XX.
- B. The CSI shall coordinate with the Contractor and equipment manufacturers as required to obtain information, submittals, materials and equipment from manufacturers, and shall provide information, submittals, materials and equipment to the Contractor and equipment manufacturers as required to execute the Work in accordance with the Contract Documents.

2.2 INSTRUMENTATION

- A. All non-vendor supplied instrumentation equipment and components shall be supplied, mounted, installed, and wired by the Contractor.
- B. All non-vendor supplied instrumentation configuration shall be performed by the Control Systems Integrator (CSI).

2.3 PANELS

- A. The CSI shall furnish or fabricate control panels, annunciator panels, relay panels and display panels, with all equipment and materials, in accordance with the

requirements of the Section entitled "Control Panels". Panels to be furnished by the CSI shall include but are not limited to the following:

1. PCS Cabinets
 2. RAS Relay Panel
 3. Scum Pump Control Panels
- B. The specific requirements for each panel are indicated on the Contract Drawings, and in specific technical specification sections referenced herein.
- C. Source Quality Control
1. The CSI shall conduct factory acceptance tests (FAT) for control panels and systems prior to shipment. The factory tests shall demonstrate that the equipment performs in accordance with the Contract Documents.
 2. Each control panel furnished by the CSI shall be assembled and wired so that it functions as a complete system for the factory test. Inputs to the control panels from field instruments and devices may be simulated during the test.
 3. The factory acceptance test shall demonstrate the proper operation of the control logic described or indicated on the Contract Drawings.
 4. Factory Acceptance Test (FAT) for PLC and PCS
 - a. The CSI shall set up a factory test, to be witnessed by the Engineer, to demonstrate the PLC programming logic and it's interface to the graphic displays on one of the OITs. OIT interface shall also be demonstrated. I/O shall be simulated to allow testing of the control logic for each system. Demonstration of alarm, trending and status displays shall be provided.
 - b. The CSI shall schedule two, two day periods to conduct the Factory Acceptance Test for testing and demonstration of the programming and I/O interface. The Contractor shall notify the Engineer in writing a minimum of 20 calendar days prior to the desired date of the Factory Acceptance Test.
 - c. Each of the factory test periods shall also be used to make modifications to the PLC logic and graphic displays, based on input from the attendees. The CSI shall provide the programming expertise required to make modifications during the testing.
 - d. Factory test shall be scheduled a minimum of 21 calendar days in advance of testing, via written communication to the Engineer. Scheduling of factory test shall coincide with scheduling of submittal requirements and submittal review.

PART 3 - EXECUTION

3.1 CSI COORDINATION AND MEETING REQUIREMENTS

A. GENERAL

1. The CSI shall perform the detailed integration and coordination of the control systems and instrumentation equipment furnished under this scope

of work. Work shall be performed by the CSI's own staff and related equipment manufacturer's engineers where applicable, including submittal drawings, operations and maintenance manuals, record drawings, equipment testing, operational demonstrations, and other applicable documentation.

2. Initial Coordination Meeting: The CSI shall be responsible for scheduling and holding an initial coordination meeting with the Owner's representative, General Contractor, and the Engineer to review the scope and schedule of the project. The meeting shall be attended by the CSI project manager, and all other parties that are involved in the integration of the control system.
3. Coordination with Process Mechanical Equipment Manufacturers
 - a. The CSI shall be responsible for coordinating with process mechanical equipment manufacturer's in order to obtain control system requirements and special control components. The CSI shall review and coordinate with the equipment manufacturer's submittals.
 - b. Obtain written verification from the equipment manufacturer pertaining to compatibility of VFDs and associated control panels with the pump motors and pumps being provided.
4. CSI Progress Meetings: The CSI shall be responsible for holding progress meetings during the course of the project to coordinate integration requirements and solicit feedback. Meetings shall be held at an agreeable time for Owner's representative, General Contractor, and Engineer. The meetings shall be held at the project site and be attended by the Owner's representative, Engineer, General Contractor's authorized representative (shall be a direct employee of the General Contractor), and the CSI. Meetings shall include a presentation of the meeting's topic by the CSI. The following topics shall be addressed by individual meetings, additional meetings shall take place as required to coordinate the work:
 - a. Control System Integration Strategy and CSI Project Plan, including preliminary Coordination Drawings
 - b. CSI Site investigations, CSI Progress Printing of Loop Diagrams, and Discussion of Programming Standards
 - c. CSI Initial Graphical Interface Screens
 - d. CSI Coordination prior to Finalization of Graphical Interface Screens

3.2 INSTRUMENTATION

- A. The CSI shall coordinate and supervise the installation of instrumentation equipment furnished by the CSI as specified. Instrumentation shall be installed in accordance with the requirements of Section "Instrumentation General" and the manufacturer's recommendations.

3.3 TEST PLANS

- A. The CSI shall assist the Contractor in developing the detailed system test plans in accordance with the Contract Documents.

3.4 FIELD QUALITY CONTROL

A. Installation

1. The CSI shall provide onsite supervision to the Contractor to have the equipment installed in accordance with the specifications and the manufacturer's requirements.
2. Control panels shall be delivered to the site with all internal wiring completed.

B. Inspections, Field Calibrations, and Functional Testing

1. Any and all testing equipment required for this project shall be owned by the CSI so as to be immediately available for this project.
2. The use of specific equipment manufacturer's startup, calibration, and trouble shooting personnel to assist the CSI shall be provided.
3. Calibrate instrumentation and place each system into operation. The commissioning of each system shall include the overall calibration and tuning of all control loops and sequences to provide stable control of the process. The validity of all process inputs and outputs for each system shall be checked and corrected during the system commissioning. Final adjustment and calibration shall be performed for all equipment prior to initiation of field testing.

C. Field Testing

1. Testing of each system shall be scheduled and performed in an orderly sequence. Testing shall be conducted for each component and system in accordance with the CSI's submitted plan that had been reviewed and approved by the Engineer.
2. Testing shall include Intermediate Point-to-Point I/O testing: the verification of all I/O, during which the Preliminary Loop Diagrams will be marked up "as built" and signed by the Electrician.
3. Testing of all modified hardware, software, process control logic, and custom control features shall also be verified.

D. Field Demonstrations

1. Demonstrate all control features of new or modified control equipment and instrumentation. Control features include relay energization, initiation of alarm conditions, resets, interlocks, failovers, set point activations.
2. Equipment shall be field demonstrated to operate satisfactorily in the presence of the Owner, and shall be conducted in accordance with the approved testing and demonstration plan. Field demonstrations shall be performed after successful installation, calibration, and testing has been completed.
3. The Contractor/CSI shall provide the necessary test equipment, process media, materials, supplies, and qualified test personnel to perform the field demonstrations as specified herein.

4. In the event of failure of the field demonstration, the Contractor/CSI shall perform the necessary corrections and re-demonstrate, at his own cost and expense, the equipment as directed by the Engineer.
5. The CSI shall provide competent personnel (minimum of two persons) to participate in the system tests as set forth in the CSI Test Plan and specified in the Supplementary Conditions.

3.5 TRAINING

- A. After the successful completion of the field testing and demonstrations the CSI shall arrange for the instruction and training of Owner selected personnel at the site in the operational procedures of each instrument, panel, software package, and control system provided by the CSI. The minimum training requirement shall be 8 hours per item type or as specific training requirements specify in other Division 40 Sections.

* * * * *

SECTION 41 67 26

PLANT MAINTENANCE WASHING EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for gas fired pressure washer equipment and associated appurtenances.

1.3 QUALITY ASSURANCE

A. GENERAL

- 1. The Contractor shall be responsible for ensuring that all equipment installed is properly connected to other related equipment for proper functioning of the plant.

B. WARRANTY

- 1. The supplier shall guarantee in writing that the equipment furnished is appropriate for the intended service and shall be free of manufacturing and fabrication defects in material and workmanship for a period of 1 year after the equipment is satisfactorily placed in service. If the equipment is not placed in service within 6 months of delivery, the 1 year guarantee period shall commence 6 months after delivery.

C. MANUFACTURER'S QUALIFICATIONS

- 1. Equipment and materials provided under this Section shall be the standard product in regular production by manufacturers who shall have at least five years experience in the design and fabrication of the equipment as described herein, used for similar applications and shall have at least five installations in satisfactory operation.

1.4 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:

- 1. Fine Screen Building Gas-Fired Pressure Washer

1.5 SUBMITTALS

- A. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:

1. All structural design calculations shall be prepared by the manufacturer and sealed by a professional engineer registered in the State of Ohio.
 2. Manufacturer's literature, illustrations, specifications, and engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.
 3. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
 4. Electrical wiring diagrams clearly indicating the required field-wiring connections.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor non-conformities, and detailed explanation of other non-conformities.
- C. Submit Operations and Maintenance Manuals in accordance with the General and Supplementary Conditions.
- D. Submit Manufacturer's Certificate in accordance with the General and Supplementary Conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND SYSTEM SUPPLIERS

- A. The project Basis of Design is Landa VH4-30024C Natural Gas Fired Hot Water Pressure Washer as described in this Section.
- B. Acceptable manufacturers:
1. Landa
 2. Or approved equal

2.2 PRESSURE WASHER

- A. Type
1. Hot water, high pressure, electric powered, gas fired stationary washer. Machine shall be capable of operating on non-potable water. The machine shall be manually operated with appropriate safety controls, with CGA, CSA, ETL or UL Certification. Must conform to UL standard 1776 for pressure washers and be built in an ISO approved factory.

B. Performance

1. Discharge 3.9 gpm
2. Pressure 3,000 psi
3. Pump RPM 775
4. Electric Motor 460 volt, 3 phase, 8.2 hp, 15 amps
5. Fuel Type natural gas

C. Hose Reels

1. All hoses shall be 3/8" ID double steel braid type meeting or exceeding SAE100R2 performance specification. Shall be equipped with swedge and strain relief collars. Rated at 4,500 psi at 275 degree F.
2. Two stainless steel hose reel assemblies shall be provided along with 150 feet of R2 3/8" HP hose for each reel assembly.

D. Trigger Spray Guns

1. Two insulated pistol type safety shut off spray guns supplied shall be rated at 10 gpm, 5,000 psi, and 300° F. Constructed from fiberglass - reinforced polyester with brass and stainless steel valves and seats.

E. Wand

1. Two 35.5" angulated wands with insulated grab handle and wand for operator protection.

F. Nozzles

1. Appropriate identifiable high pressure nozzle for single spray gun operation shall be supplied in 0°, 15°, 25°, 40° spray patterns. The nozzle shall be of a through hardened 420 stainless steel material with an interlock coupler nipple made of annealed 303 stainless steel with 80 Rockwell hardness rating. One set of nozzles shall be supplied for each hose reel.

G. Drives

1. Belt drive system with cast iron pulley, grip notch V-section size B belts, and adjustment plate for proper belt tension and alignment. All belts to be covered by safety machine cover.

H. High Pressure Pump

1. Ceramic plunger, oil bath crankcase type with forged brass head, rated 3,500 psi. Pump bypass loop shall be equipped with 145° F. thermal relief valve to protect pump from high inlet water temperature.

I. Unloader Valve

1. The pressure washer shall be equipped with a pressure trapping unloader valve suitable for single spray gun operation rated for 4,200 psi and 7.8 gpm, to prevent excessive pressure and thermal expansion damage.

J. Frame

1. Machine shall be surrounded/protected on all sides by a steel frame/ cover assembly. Components to be located for service/inspection accessibility by a quick release service panel. All painted material will be painted with an epoxy powder coating. The motor and pump shall be mounted on a platform with vibration isolators.

K. Controls/Gauges

1. Machine shall have control panel and chassis with the following:
 - a. Lexan plastic operating instructions and safety information in English, French and Spanish, attached by a high strength adhesive.
 - b. Magnetic motor control with overload protection on three phase machines
 - c. Individual burner control switches
 - d. All controls are located in an enclosure to protect from moisture
 - e. Metering detergent valve

L. Hose Quick Connections

1. ST series quick coupler with stainless steel support balls.

M. Burner Assembly

1. Type
 - a. Must comply with CSA standard B140.11-M89 for Commercial/Industrial steam cleaning machines, CAN1-2-2.17-M91 gas-fired appliances for use at high altitudes CSA C22.2 No. O-M1991 general requirements - Canadian Electrical Code, Part II. CSA C22.2, No. 3-M1988 Electrical Features of Fuel - Burning Equipment, or ETL standard UL 1776 for pressure washer cleaning equipment. Natural draft, standing pilot of sufficient capacity to provide 150° F temperature rise. A manually operated pilot shut-off valve shall be provided to independently shut-off the supply of gas to the pilot. Particles from the burner and coil assembly are prevented from falling on the floor by a steel tray. A self generating thermopile shall be installed into the pilot flame as a burner

safety control. Means are provided to immediately detect, visually, the presence of the main flame.

- b. Draft Diverter – one 10” diameter stainless steel flue shall be provided.

N. Heating Coil

- 1. Schedule 80 A53 cold formed duracoil, with a material thickness of .147 in. (3.73 mm), overall length 176 ft. (46.9 m), pipe dimension .840 OD. Welding done to ASME standards. The heating coil shall be insulated with a fiberfrax ceramic blanket, # 6 density, 1 in. thick.

O. Safety Relief Valve

- 1. A rupture is disk located at the discharge port of the coil for added protection.

P. High Temperature Safety Control

- 1. Shall be of the direct immersion type located at discharge of coil with a minimum operating temperature setting of 225° F. This safety control shall control the gas valve assembly for dependability.

Q. Safety Flow Switch

- 1. Shall be located on cold water discharge side of pump to prevent thermal damage. This flow switch will be hermetically sealed to prevent moisture damage. Flow switch to control opening and closing of gas valve.

R. Water Supply System

- 1. A reinforced polyethylene water tank with automatic float shut-off valve shall be permanently mounted to machine to supply water to high pressure pump. Its special design shall meet back-flow prevention standards as they apply to this type of equipment. A fine mesh inline filter shall be installed at two locations to adequately protect high pressure pump, from debris entering pump.

S. Time Delay Shutdown

- 1. This machine shall be equipped with a shut-off timer to turn the machine off in the likely event that the machine is left on and unattended.

T. Electronic Ignition

- 1. 24 Volt Electronic Ignition.

U. Spare Parts

- 1. None

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with Manufacturer's instructions and recommendations.
- B. Coordinate work with plumbing and piping and related fuel piping and gas venting work to achieve an operating system.
- C. Clean and flush tank after installation. Seal equipment connections until ready for piping or vent tie-in.

3.2 MANUFACTURER'S FIELD SERVICE

- A. Provide manufacturer's services at the jobsite designated by the Owner for the minimum hours listed below, travel time excluded:
 - 1. Minimum 1-8 hr day (1 trip) for installation supervision, start-up and field testing services and O&M training services.
 - 2. The manufacturer shall provide start-up reports covering installation inspection and start up activities.
 - 3. The manufacturer shall provide operator training to all required plant personnel.
- B. After installation supervision and field testing services by the manufacturer, the contractor shall submit to the engineer, a certification letter on the manufacturer's letterhead and signed by the manufacturer certifying that the equipment was installed per the manufacturer's recommendations.
- C. Jobsite visit shall be scheduled with minimum seven (7) calendar days notice prior to each visit. The service visit for operational training shall be scheduled in coordination with the Owner's operations staff and shall be at such times as requested by the Owner.
- D. Above services shall be provided by the manufacturer's qualified factory-trained service staff.

SECTION 43 08 20.11

TESTS ON PUMPING EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Conditions and Division 01 of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for tests on pumping equipment including the following for each pump provided:
 - 1. Shop hydrostatic testing.
 - 2. Shop performance testing.
 - 3. Field running and performance testing.
 - 4. Field vibration testing.

1.3 REFERENCES

- A. Testing shall be in accordance with the latest revisions of the Test Code of the Hydraulic Institutes Standards (HIS), except where more stringent requirements have been specified herein

1.4 SUBMITTALS

- A. Contractor shall submit shop drawings in accordance with General and Supplementary Conditions and Division 01.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.
- C. In addition to those submittals identified in the General and Supplementary Conditions and Division 01, the following items shall also be submitted:
 - 1. The Contractor shall submit a detailed testing plan to the Engineer for all field testing specified herein. The testing plan shall be approved prior to the initiation of the field tests. The testing plan shall include the Contractors schedule and procedures for conducting all field tests.

2. Five copies of the shop hydrostatic test results.
3. Five copies of the shop performance test results in the form of performance curves certified as to actual test date and witness for each pump tested.
4. Five copies of field running test results shall be submitted. Field test results shall also be included in the Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.1 GENERAL

- A. Model Test for Performance will not be allowed.
- B. Shop testing may be witnessed by the Engineer where indicated in the technical specifications. The Contractor shall give the Engineer fourteen (14) calendar days notice prior to scheduled shop testing.

2.2 TEST EQUIPMENT

- A. Manufacturer shall furnish materials and equipment including drives required to perform shop test.
- B. Contractor shall furnish materials and equipment required to perform field test.

PART 3 EXECUTION

3.1 SHOP HYDROSTATIC TEST

- A. Hydrostatic pressure test shall be at a pressure equal to twice the specified shut-off head or 150 psi, whichever is greater.
- B. The casings and heads shall show no:
 1. Undue deflection
 2. Sign of weakness
 3. Sweating through porous metal
 4. Leakage

3.2 SHOP PERFORMANCE TESTING

- A. The pump manufacturer shall perform the following inspections and tests on each pump before shipment from the factory.
 1. Impeller, motor rating, and electrical connections shall be checked for compliance with specifications.
 2. A motor and cable insulation test for moisture content or insulation defects

shall be made.

3. The pump shall be run dry to establish correct rotation and mechanical integrity.
 4. The pump shall be run wet for 30 minutes.
 5. During the test under item 4), amperage and voltage shall be recorded.
 6. After operational test under item 4), the insulation test under item 2) is to be performed again for submersible motors.
 7. Immediately prior to shipment, each pump cable end shall be fitted with a shrink fit rubber boot or plastic dipped to protect the pump from water seepage that could occur on site before electrical installation is complete.
- B. Electrically and functionally test the pump control components prior to shipment.
- C. For submersible pumps and dry-pit submersible pumps, submerge pumps for at least 2 hours after which a megger test shall be performed on the motor windings and cables. Record results.
- D. Each pump shall be tested at maximum rated speed over a range of operating conditions (minimum of six evenly spaced test points plus the pump shut-off point), consistent with the design or performance criteria as specified in the technical specification for the pumping equipment, to develop its performance curves for:
1. Head-capacity (TDH-Flow)
 2. Power input (BHP)
 3. Efficiency
 4. Net Positive Suction Head Required
- E. A written report certifying the foregoing steps shall be supplied with each pump.

3.3 FIELD RUNNING AND PERFORMANCE TESTING

- A. Each pump assembly with its drive unit and auxiliary equipment shall be field tested after installation.
- B. The pump manufacturer or manufacturer's representative shall be present during the field running and performance testing. Where pumps are equipped with variable frequency drives (VFD), the VFD manufacturer or manufacturer's representative shall also be present during all tests.
- C. The Contractor shall provide test water to conduct the field running and performance tests. Wet well(s) and piping which are part of the pumping system being tested shall be filled with test water to design elevations unless otherwise directed. The Contractor

shall provide continuous flow of test water as required to conduct the performance running tests specified herein.

- D. Tests shall not be started on any pump assembly until the pump manufacturer or pump manufacturer's representative is present and has completed the inspection for proper assembly, erection and alignment. Manufacturer or manufacturer's representative shall provide Certification of Installation, in accordance with the General Conditions and Division 01.
- E. Test shall be conducted by the Contractor and the pump manufacturer or manufacturer's representative and witnessed by the Engineer, and shall demonstrate the following under operating conditions:
 - 1. Pump has been properly installed and has no mechanical defects.
 - 2. Pump is in proper alignment and has been properly connected.
 - 3. Pump is free from undue vibration over the full range of operating conditions.
 - 4. Pump is free from overloading and overheating.
- F. Power for testing shall be provided by the Contractor.
- G. The following field running performance tests shall be conducted by the Contractor. Each pump assembly with its drive unit and auxiliary equipment shall be tested.
 - 1. Demonstrate that pump check valves open properly at pump start up. Where check valve limit switches are provided, demonstrate that these operate properly.
 - 2. Demonstrate proper functioning pump discharge and/or suction pressure gages. Verify that pressure gage instrument range is as specified.
 - 3. Where air/vacuum release valves are provided as part of the pumping system, demonstrate proper operation during pump start and stop.
 - 4. Where pump control valves, pressure switches or other pump control equipment or accessories are provided and required for pump operation, the Contractor shall demonstrate that such equipment and accessories are functioning as intended.
 - 5. Operate each pump at rated speed for 30 minutes without other pumps running and record the following data at every 5 minute interval:
 - a. Pump suction and discharge pressures
 - b. Volts and amps on each phase
 - c. Flow rate (where flow meters are part of the pumping system, installed and calibrated)

- d. Hertz output from drive for pumps with VFD equipment
- 6. For pumps equipped with VFDs, operate each pump at minimum speed (at which speed the pump discharge is greater than zero) 15 minutes without other pumps running and record the above data at every 5 minute interval.
- 7. Compare the above data with the certified pump performance curves.
- 8. Verify two additional operating points on the certified pump performance curve for each pump by recording discharge flow rates and suction/discharge pressures for:
 - a. Throttled conditions (partially close the pump discharge valve, or other downstream isolation valve).
 - b. Shut-off conditions (record pump shut-off pressure by closing the pump discharge valve – discharge flow rate is zero).

Confirm with the pump manufacturer before conducting the pump shut-off test.

- 9. For variable speed controlled pumps, repeat the above “rated speed” test only, for each pump at a speed of 75% (or as otherwise directed by the Engineer) of the rated pump speed.
- 10. Where two or more pumps are tested, the Contractor shall run all pumps simultaneously. The design dedicated stand-by pump shall not be running. Test duration shall be 5 minutes. Record total discharge flow rate. The Contractor shall provide the test water quantity necessary to conduct this test.
- 11. Where flow meters are not part of the pumping system, quantification of discharge flow rate shall be based on wet well draw-down (suction side of pump), or wet well (tank) fill-up (discharge side of pump). Supply of test water in the “draw-down” mode shall be halted during the draw-down test.
- 12. Where flow meters are used for discharge flow rate recording, a minimum of one “draw-down” or “fill-up” test shall be conducted when feasible to compare flow meter readings. Draw-down volume (or equivalent wet well level change) and draw-down time shall be recorded. Average flow rate shall be computed as the draw-down volume divided with the draw-down time. During the draw-down period, the flow meter reading shall be recorded at five different times and averaged. If the flow meter readings are not in line with the testing, the Contractor shall check/calibrate the flow meters and re-test at the direction of the Engineer.

3.4 FIELD VIBRATION TESTING

A. General

- 1. Perform a vibration analysis on all pumps after they are installed and ready to run. All vibration readings used for acceptance shall be taken with the pumps operating at the primary design point. The vibration analysis shall be

performed by qualified technicians. The technicians credentials shall be approved by the Engineer prior to start of testing. An authorized representative of the Authority shall witness the testing.

2. Overall lateral vibrations (i.e. vibrations acting side-to-side, up and down, or axially) shall be analyzed in the field. At a minimum, points to be analyzed shall include pump base plate, pump casing, and pump motor.
3. A background preliminary vibration check shall be taken on each pump to be tested with the pump off. Any background vibration from sources outside the machine being tested shall be accounted for in the running pump vibration levels.

B. Vibration Testing

1. Vibration shall be measured with an FFT analyzer or data collector. Spectrum plots shall be provided in printed form. The test equipment shall be capable of providing a complete broadband or "Overall (OA)" value in addition to individual frequency components. The type, model, serial number, and latest certified calibration date of all test equipment used in the measurement of vibration levels for machine acceptance shall be documented. Measurements shall be taken with a Hanning Window setting and four linear, non-overlapping averages.
2. The sensor used shall be an accelerometer with a magnetic mount. Handheld pickups are not acceptable unless machine casing design interferences preclude the use of a magnetic base. The magnetically mounted sensors shall be mounted such that the magnetic base can be attached firmly without rocking.
3. Vibration amplitude readings in inches/second peak vs. frequency in cycles per minute (CPM) shall be used. Both a vibration spectrum and overall value shall be recorded for each measurement point shown on the testing diagram at the end of this section.
4. When coupled or belt-driven equipment is running and operating under load, record vibration data. If the equipment fails to meet the vibration tolerances, record the vibration readings on the driver unit disconnected from the driven equipment. Use this data to compare with the vibration of the complete unit to determine the source of the problem.

C. Documentation

1. Four copies of the vibration report on tested machinery shall be submitted to the Engineer:
 - a. Outlining the procedures used;
 - b. Stating the vibration standards used for the equipment;
 - c. Stating the analysis results for each piece of equipment;
 - d. Discussing the source of any unacceptable vibration found (rotor

unbalance, shaft misalignment, bearing problems, vane pass vibration, etc.) and recommended actions to correct.

2. A complete set of vibration spectra shall be submitted for each piece of equipment tested.

D. Vibration Tolerances

1. Vibration tolerances to be applied to each measurement point on the pumps in the field shall be as follows:
 - a. The “Overall (OA)” or total broadband unfiltered reading shall be no more than 0.25 inches/ second peak vibration velocity.
 - b. Vibration tolerances to be applied to the individual frequency peaks in the vibration spectrum shall be as follows:

<u>Frequency Range</u>	<u>Tolerance</u>
Subsynchronous (below motor RPM)	No vibration peaks in excess of 0.03 inches/second peak vibration velocity
At motor or pump RPM	Not to exceed 0.10 inches/second peak vibration velocity
At impeller blade pass frequency (number of impeller blades times pump RPM)	Not to exceed 0.15 inches/second peak vibration velocity
Above impeller blade pass frequency out to 120,000 cycles per minute (CPM)	No vibration peaks in excess of 0.08 inches/second peak vibration velocity

2. On variable frequency drive (VFD) applications, vibration shall be evaluated against the tolerances as follows:
 - a. Store and evaluate the vibration data against the above tolerances at all measurement points designated on the attached testing diagram under full speed conditions. These readings shall be included in the vibration report.
 - b. Select the measurement point with the highest amplitude vibration frequency of interest and/or overall vibration level and place the accelerometer at that location.
 - c. The equipment speed shall then be manually reduced at the VFD in 1 Hertz increments from full speed to designed minimum speed (or flow) while observing or storing (vibration analyst option) the vibration data.

- d. Note and record any significant increases in vibration which may indicate a critical speed or resonance problem. Also note and record the pump shaft speed or VFD Hertz output setting at which the problem (if any) occurs.

3.5 ACCEPTANCE

- A. Acceptance of hydraulic performance shall depend upon satisfactory shop performance test as demonstrated by certified performance curves.
- B. Final acceptance of each pumping unit shall depend upon satisfactory operation as demonstrated by the field running test and operation under field conditions.
- C. Prior to final acceptance the Contractor shall correct all deficiencies.

3.6 FINAL ALIGNMENT

- A. After 24 hours of operation the alignment of the unit shall be checked and adjusted, if required.
- B. Check the unit for being "pinned", where required.

* * * * *

SECTION 43 11 23.11.1

AERATION BLOWERS

CONTROL PANEL MODIFICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Replace existing Aeration Blower Control Panels and instrumentation with new control panels and instrumentation, as shown on the Drawings and specified herein
- B. Add ancillary instruments equipment for measurement and indication.
- C. The contractor will be given a copy of the existing blower control PLC program to use as a starting point for making the specified blower modifications.
- D. The contractor will be given a copy of the existing blower performance curves.

1.2 EQUIPMENT

- A. Equipment covered under this specification is identified as follows:
 - 1. IFAS Blower No. 1 (Ex. Aeration Blower No. 1)
 - 2. IFAS Blower No. 2 (Ex. Aeration Blower No. 2)
 - 3. IFAS Blower No. 3 (Ex. Aeration Blower No. 3)
 - 4. IFAS Blower No. 4 / Eq. Basin Blower (Ex. Diurnal Blower No. 1)
 - 5. IFAS Blower No. 5 / Eq. Basin Blower (Ex. Diurnal Blower No. 2)
 - 6. IFAS Blower No. 6 / Eq. Basin Blower (Ex. Diurnal Blower No. 3)

1.3 REFERENCES

- A. Comply with the latest revision of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. NFPA 79 Electrical Standard for Industrial Machinery
 - 2. UL 508A Standard for Industrial Control Panels
 - 3. National Electric Code (NEC)
 - 4. National Electric Manufacturers Association (NEMA)
 - 5. Underwriters Laboratories, Inc. (UL)
 - 6. American National Standard Institute (ANSI)
 - 7. Occupational Health and Safety Administration (OSHA).

1.4 COORDINATION

- A. Provide control panel(s) with dimensions as required and not to exceed the existing spacing. New panel shall be located within the existing spacing in the Electrical Room.
- B. Re-use existing conduits and wiring to Motor Controllers (VFD), Process Control System, blower instrumentation and field instruments as much as practical. Provide new conduits to new equipment or to as a result of damaged raceways.
- C. Run new wiring to new instrumentation sensors.
- D. Pre-Installation Meetings: Present proposed scope and schedule for installation of replacement control panels and instrumentation to the Owner and the Engineer.
- E. Coordination: Coordinate selection of variable frequency controller equipment provided under other Sections in order to meet equipment performance ratings. Provide acceptance from blower manufacturer that the VFD selected is appropriate for blower control.
- F. Monitoring and Control: Coordinate monitoring, control, sequencing, setpoints, tags, and other control systems with the IFAS system supplier, to allow monitoring and control of blower systems from IFAS system control panels and SCADA system.
- G. Sequencing: Replace one blower control at a time. Coordinate with Owner.
- H. Scheduling: Schedule Blower Control Panel Replacement to be completed during the first year of the Contract and in coordination with IFAS system.

1.5 GENERAL DESCRIPTION OF EXISTING SYSTEM

- A. The existing Blower System consists of six centrifugal blowers (three large and three small, as described below) that supply air to the existing basins. The large blowers provide air to three Aeration Basins while the small blowers provide air to an Equalization Retention Basin (also referred as Diurnal Basin). Blowers have a common suction header and split discharge headers to feed the basins.

Large Blower (350Hp): 8,061 CFM; Discharge Press: 7.14 PSIG

Small Blower (200HP): 4,030 CFM; Discharge Press: 7.14 PSIG

- B. The existing large blowers were designed to provide the necessary air to the Aeration System to maintain DO in the aeration basins. The Aeration System consists of a control panel with a dedicated PLC for each of the blowers to provide control and protection of each blower. A master PLC provides the process control logic to control the DO concentration. A second PLC is installed at the Aeration Tank area to collect the DO signals from the DO probes, air flow transmitters and air flow control valves.

- C. The existing small blowers were designed to provide the necessary air to the Retention Basin System. The system consists of a control panel with a dedicated PLC for each of the blowers to provide control and protection of each blower. A master PLC provides the process control logic.
- D. Each existing Blower consists of Blower Inlet Valves, Blower Outlet Valves, Variable Frequency Drive, Thermal Mass Flow Meter, Suction/Discharge Pressure Transmitters, Discharge Temperature Transmitters and Vibration Transmitters.
- E. Additionally, the discharge header has a Differential Pressure Transmitter that provides input to the Aeration System
- F. Both blowers systems are interconnected by a pipe to provide process flexibility. This interconnect pipe has a Thermal Mass Flow Meter that provides input to the Retention Basin System.
- G. Refer to Section 1.11 for proposed modifications to the control system for the existing blowers.

1.6 SUBMITTALS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Shop Drawings: The control panel fabricator shall provide a complete set of control panel drawings and related documentation for use by the equipment installer and Owner's maintenance staff for installation of the equipment, interconnection with associated equipment, and troubleshooting. This technical documentation shall generally conform to NFPA 79 Electrical Standard for Industrial Machinery, using ANSI standard symbols.
- C. Control Panel Shop Drawings shall include the following:
 - 1. One-line and 3-line power wiring diagrams
 - 2. Control panel general arrangement drawings, including plans, sections, elevations, internal layout, and door layout.
 - 3. Complete bill of materials indexed to the control panel general arrangement drawings and wiring diagrams, with manufacturer's product data for each component. Indicate selections on manufacturer's catalog data sheets, and cross out inapplicable data.
 - 4. Schematic wiring diagrams, including control elementary (ladder) diagrams, showing the following:
 - a. Schematic (ladder) line numbers
 - b. Relay contact reference line numbers (underline NC contacts)
 - c. Wire numbers
 - d. Device numbers
 - e. Terminal numbers
 - f. Annotations of control switch action and relay logic names

5. Equipment that includes factory-installed Programmable Logic Controllers (PLCs) shall also include the following additional documentation:
 - a. PLC input and output layout
 - b. PLC termination diagram
 - c. PLC logic in fully annotated elementary (ladder) diagram format
 6. UL 508A (Industrial Control Panels) listing certificate.
- D. Operation and Maintenance Manuals shall include the following:
1. Record (as-built) copies of all reviewed shop drawings.
 2. Wiring diagrams incorporating all field changes and Engineer's comments.
 3. Manufacturer's instructions on care and operation of equipment.
 4. Warranty certificates.
 5. Spare parts list.
 6. Complete typewritten operating instructions, covering all system descriptions and operation, emergency operating instructions and precautions.
 7. Name, address and telephone number of supplier or representative of manufacturer for each item of equipment in Contract.
 8. Bind above items (all unused, clean, and legible) in common folder or heavy notebooks cover and submit to Engineer for before request for final acceptance.
- E. Factory Test Reports
- F. Manufacturer's Installation Instructions
- G. Manufacturer's Installation Certificate
- H. Closeout Submittals
1. Warranty Documentation
 2. Software: program documentation

1.7 QUALITY ASSURANCE

- A. Like items of equipment specified herein shall be the end product of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturer's services.
- B. Blower packages shall be furnished by the blower manufacturer or a factory authorized distributor who maintains a factory certified service shop and is authorized to perform warranty service.

1.8 DELIVERY, STORAGE AND PROTECTION

- A. Deliver control panels and accessories in moisture-resistant protective packaging.
- B. Store control panels in clean dry indoor rooms with a temporary dehumidifier and electric heating to maintain the storeroom between 5 and 40 deg. C with humidity less than 90%.

Comply with manufacturer's additional written instructions for storing and periodic inspection and testing. Energize control panel anti-condensation heaters during storage periods exceeding two weeks.

- C. Handle components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.9 GUARANTEE

- A. Provide a guarantee against defective equipment and workmanship in accordance with the requirement of the General and Special Provisions.
- B. The equipment under this Section shall be warranted to be free of defects in material and workmanship, including damages that may be incurred during shipping, storage and installation for a period of two (2) years from date of equipment acceptance.

PART 2 - PRODUCTS

1.10 SYSTEM SUPPLIER

- A. Manufacturer: Gardner Denver, Inc., Industrial Products Group, 100 Gardner Park, Peachtree City, GA 30269.
 - 1. Contact: Greg Liddle, CF Global Operations, PO Box 130, Bentleyville, PA 15022. Tel (724) 239-1576
- B. If any other manufacturer listed in this Section is proposed by the Contractor for the Work covered in this Section, it shall be the responsibility of the Contractor to perform any required redesign and coordination associated with, but not limited to, mechanical equipment layout, electrical wiring, conduit and controls, and structural/architectural work, at no additional cost to the Contract.
- C. No substitution of the listed manufacturer(s) will be allowed without prior approval by the Engineer, in accordance with the requirements outlined on the Bid Form.

1.11 BLOWER CONTROL PANEL (BCP)

- A. General
 - 1. Blower Equipment consisting of Variable Frequency Drive, Suction Thermal Mass Flow Meter, Discharge Pressure Transmitters, Bearing RTD's and Vibration Sensors shall be added/replaced under this Contract, as shown on the Drawings.
 - 2. Aeration System equipment consisting of Air Header Temperature Transmitter, redundant Air Header Pressure Transmitters and an Interconnect Thermal Mass Flow Meter shall be added under this Contract, as shown on the Drawings.

3. Blower Control Panel shall be replaced to provide and perform the control function as shown on the Contract Drawings and specified herein. Controls shall include control power transformers, circuit breakers and power disconnecting devices and hardware, relays, PLC controllers, I/O modules, OIT displays and miscellaneous controls as required, or as specified.

B. Control Panel

1. Three Blower Control Panels shall be removed and replaced by a single control panel, located in the Aeration Tank Blower Building, Electrical Room.
2. Control panels and components shall be in accordance with the Sections 26 09 16 "Electrical Controls and Relays" and 40 96 00 "Control Panels."
3. One (1) UL-508 control panel, NEMA 12, steel, Freestanding Enclosure, 120 volt, single phase 60 Hertz input power connection.
4. Provide the following centrifugal blower protection, control, and monitoring functionality:
 - a. Blower surge and overload protection of each blower
 - b. Blower vibration and bearing temperature
 - c. Blower suction and discharge pressure
 - d. Blower discharge temperature
 - e. Remote (Auto) and local (Hand) control of blowers
 - f. Provide blower sequencing to provide air flow requirements to IFAS system
 - g. Provide control of blowers based on control strategies
 - h. Inputs and outputs:
 - 1) Blower remote control (volts-free contact input from Process Control System closes to run blower in Auto)
 - 2) Common Shutdown Alarm (volts-free contact output)
 - 3) Common Warning Alarm (volts-free contact output)
 - 4) Blower Inlet Bearing Vibration Warning Alarm
 - 5) Blower Outlet Bearing Vibration Warning Alarm
 - 6) Blower VFD Speed and status information
5. Information to be monitored from each VFD with an Ethernet connection includes:
 - a. Voltage Phase A, Voltage Phase B, Voltage Phase C
 - b. Current Phase A, Current Phase B, Current Phase C
 - c. Power Factor
 - d. Power (KW)
 - e. VFD common fault
6. Provisions shall be made to connect the Blower Control Panel to the plant Process Control System (PCS). The system supplier shall provide within the control panel the following:
 - a. Ethernet switch with at least 2-FX and 8 TX, RJ-45 ports
 - b. Fiber patch panel

- c. Uninterruptible power supply (UPS); Min. size 1000VA
- 7. Programmable controllers shall be Allen-Bradley ControlLogix PLC (1756-L73), with Ethernet communications (1756-ENTB) to plant network .
- 8. Provide the following door-mounted devices and indications:
 - a. Control Power ON-OFF Circuit Breaker operating handle
 - b. Allen Bradley 12 inch touch screen HMI, Ethernet enabled, with the following controls and indicators:
 - 1) Blower HAND-OFF-AUTO selection
 - 2) Blower VFD HAND - AUTO indication
 - 3) Blower VFD Speed Selection
 - 4) Blower VFD Speed Indication (% speed)
 - 5) Blower Inlet Bearing Vibration Indicator (in/sec)
 - 6) Blower Outlet Bearing Vibration Indicator (in/sec)
 - 7) Blower SURGE and OVERLOAD indicator (%)
 - 8) Blower Inlet Air Temperature (°F)
 - 9) Blower Discharge Air Temperature (°F)
 - 10) Blower Suction Pressure (psi)
 - 11) Blower Discharge Pressure (psi)
 - 12) Blower RUNNING indication
 - 13) Blower OFF indication
 - 14) Blower Impending Surge Alarm indication
 - 15) Blower Surge Alarm indication
 - 16) Blower Impending Overload Alarm indication
 - 17) Blower Overload Alarm indication
 - 18) RESET
 - 19) Redundant Header Pressure (psi)
 - 20) Header Temperature (°F)
 - 21) Interconnect Piping Flow (SCFM)
- 9. Factory Assembly
 - a. Blower Control Panel shall be manufactured in accordance with the factory quality certification documents.
- 10. Factory Test
 - a. Each Blower Control Panel shall be factory tested as follows:
 - 1) Manufacturer's standard inspections and tests
 - 2) Submit factory test report prior to shipment
- C. Control Description
 - 1. The aeration blowers shall run continuously to supply air requirement to the IFAS system and the optional Equalization Basin. Blower Control Panel shall automatically adjust blower speed in order to maintain a desired dissolved oxygen level in IFAS.
 - 2. Blower Control Panel shall control a total of six centrifugal blowers; three large blower and two small blowers shall be used for IFAS aeration, while the third small blower shall be used for the optional Eq. Basin aeration. Control panel shall allow manual and automatic selection of blower configuration for the two

basins. Selection of Eq Basin blower shall disable this blower from automatic rotation in the IFAS system. Eq Blower shall be a manual operation.

3. The Blower Control Panel shall automatically alternate the blowers once every 24 hours (adjustable with Operator password), at the time of day entered on the OIT system, or if the blower selected to operate is "unavailable". [A blower is "unavailable" due to a VFD fault or if it's local H-O-A switch is not in "Auto" position].
4. Blower vibration switches are monitored by the BCP for indication/alarming on the local HMI and remotely at the SCADA system and for protective action. A High-High vibration shall shutdown the troubled blower and disable it until manually reset. High-High vibration is also indicated and alarmed on the SCADA system.
5. The discharge pressure of each blower is monitored by the BCP for low pressure and high pressure indicating/alarming (with time delay) on the local HMI and remotely at the SCADA system and for protective action. A High-High discharge pressure shall shutdown the troubled blower and disable it until manually reset. High-High discharge pressure is also indicated and alarmed on the SCADA system.
6. Provision shall be made to receive analog and status point values from IFAS system as follows:
 - a. Receive air concentration requirements for blower control in total CFM and SCFM.
 - b. Receive status points from the IFAS System defined as: Off-line, Faults, DO concentrations, etc.
 - c. Receive the DO control loop status from the IFAS System.
7. Automatic control of each blower shall be performed by the BCP when the corresponding blower is selected for "AUTO" at the local HOA at the blower VFD control panel. The BCP shall include a [MANUAL/AUTO] commands to select the blower "Control Mode". All blowers shall be capable of being started and stopped either manually or automatically.
 - a. When selected for [MANUAL], the operator shall be able to control the blower control loop output as described in the "MANUAL Control" section below.
 - 1) Operator shall start and stop each blower via [START/STOP] commands.
 - 2) Positive displacement blowers operating speed shall be manually adjusted by the Operator to meet speed set-point.
 - b. When selected for [AUTO], the Blower Control Panel shall automatically start/stop blowers, adjust speed, etc. to maintain DO setpoint as required by the IFAS system.

- 1) The BCP shall control the blowers to maintain the header pressure which allows the IFAS System air flow valves to modulate independently to minimize the affect one biological reactor to another. Header pressure shall be kept constant by a separate header pressure control loop, which will vary a capacity control output. The capacity control output shall control the number of blowers called, existing blower motor current setpoints and VFD speed.
- 2) BCP shall decrease capacity control upon increasing header pressure and increase capacity control upon decreasing header pressure. A time delay shall be programmed after each header pressure set-point changes, to give the increased air flow time to affect the DO and the biological reactor valves time to respond to the change.
- 3) The BCP shall determine from blower curves which blowers to run to maintain best efficiency, maintain header pressure and temperature. At least two large blowers and 1 small blowers are required to run to meet regulations.
- 4) A Start delay (adjustable from 0 to 30 min) in the PLC shall keep more than one blower from starting simultaneously to limit power demand.

1.12 INSTRUMENTATION

A. Flow Element/Transmitter – Air/Gases – Indicating

1. The airflow sensor shall be of the “thermal dispersion” type and shall be have operating temperature up to 350 degrees F, and an operating pressure of up to 250 psig. Sensor probe to be constructed of 316 stainless steel/nickel brazed, and resistant to corrosion and abrasion
2. Provide an isolated 4-20 mA output directly proportional to the measurement.
3. Integral or remote digital indicator for displaying process variables in Engineering Units, as shown on drawings.
4. Process connection: male NPT of 1/2 inch. Coordinate process connection with other contracts.
 - a. Large Blower Suction Pipe Diam: 20”
 - b. Small Blower Suction Pipe Diam: 14”
 - c. Interconnect Piping Diam: 20”
5. Manufacturer/Model: Fluid Components, Inc. (FCI) – ST50, Magnetrol or approved equal

B. Pressure Element/Transmitter – Indicating

1. Microprocessor based digital transmitter with 1/2"NPT process connections with operating temperature of –20°F and 185°F. The transmitter shall include local span and zero adjustment buttons or pots and have integral transient protection.
2. Provide a 4-20 mA analog signal proportional to process pressure.
3. Integral digital indicator for displaying process variables in Engineering Units.
4. Provide a stainless steel 3-way valve manifold to permit zero checks, calibration, and isolation of the transmitter.

5. Process connection: male NPT of 1/2 inch. Coordinate process connection with other contracts.
 - a. Large Blower Discharge Pipe Diam: 20"
 - b. Small Blower Discharge Pipe Diam: 14"
 - c. Common Discharge Header Piping Diam: 40"
 6. Manufacturer/Model: Rosemount 3051 or approved equal
- C. Temperature Element/Transmitter – Bearing (RTD)
1. Temperature indicating-transmitters shall be microprocessor-based with "smart" electronics, capable of accepting direct inputs from temperature detectors (RTD) from 10 to 1000 ohms. Operating temperature of –40°F and 350°F. Alternatively, RTD may be directly connected to controller, provided RTD modules are provided and compatible with sensors.
 2. Provide a 4-20 mA analog signal proportional to temperature.
 3. Process connection: male NPT of 1/2 inch. Coordinate process connection with other contracts.
 - a. Common Discharge Header Piping Diam: 40"
 4. Manufacturer/Model: Rosemount 248 or approve equal
- D. Vibration Element/Transmitter
1. Vibration-transmitters capable of accepting direct inputs from sensors. Operating temperature of –40°F and 350°F.
 2. Process connection: male NPT of 1/2 inch. Coordinate process connection with other contracts.
 3. Manufacturer/Model: Sonosonics, IMI Sensors or approve equal

1.13 SPARE PARTS

- A. Furnish the following spare parts for the specified equipment:
1. One temperature RTD
 2. One pressure transducer
 3. One flow sensor
 4. One box of min. 10 fuses of each size furnished
 5. One spare relay of each type furnished
- B. Package spare parts in wooden boxes, labeled with the manufacturer's name, address and telephone number; local representative's name, address and telephone number; name of equipment the parts are for and list of parts contained therein

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall install all equipment in accordance with the manufacturer's recommendations. The Contractor shall make all necessary adjustments to equipment to

provide complete operational positive displacement blower equipment systems upon completion of the Project.

3.2 PREPARATION

- A. Conduct a field survey of the existing Aeration Blower Control Panels as preparation for configuring the replacement unit(s) to re-use the existing conduit, and wire connections. The field survey shall include confirming the wiring connections from each field-mounted device to each terminal in the Blower Control Panel, and from each VFD terminal to each terminal in the Blower Control Panel.

3.3 INSTALLATION

- A. Install replacement Blower Control Panels in place of the existing Blower Control Panels, in accordance with the manufacturer's installation instructions.
- B. Re-use existing conduit connected to existing control panel.
- C. Mount and connect new instrumentation equipment in existing process connections, as much as possible. Provide any necessary piping, hardware and connections if existing are damaged, or at the discretion of the engineer.
- D. Install new thermowell and RTD in common discharge air header pipe. Connect transmitter to control panel. TIG-weld a stainless steel half-coupling in the suction pipe for the thermowell. Remove all cuttings from the inlet pipe before turning on the blower.
- E. Calibrate instrumentation and place each system into operation. The commissioning of each system shall include the overall calibration and tuning of all control loops and sequences to provide stable control of the process. The validity of all process inputs and outputs for each system shall be checked and corrected during the system commissioning. Final adjustment and calibration shall be performed for all equipment prior to initiation of final testing.

3.4 MANUFACTURER'S FIELD SERVICES

- A. The Contractor shall engage the services of a qualified factory trained manufacturer's field service engineer to be present at and assist in the startup of all equipment under this Section. The duration of the service shall be as required to complete the successful start-up of the equipment.
- B. The manufacturer's field service engineer shall start and operate the equipment and conduct field tests to adequately show that the equipment has been properly installed and will function as herein specified. All tests shall be subject to the Engineer's review. Contractor shall demonstrate that each part individually and all parts together, including appurtenances, function properly in the manner intended.

- C. Correct or replace all defective equipment revealed by or noted during field tests at no additional cost to the Owner and repeat field tests until specified results are acceptable to the Engineer.
- D. The manufacturer's field service engineer shall instruct and train the Owner's operating personnel in proper operation and maintenance procedures for the equipment installed under this specification. On-site start-up and training time shall include a minimum of 8 hours.
 - 1. Review data in Operation and Maintenance manuals.
 - 2. Schedule training with Owner.
- E. Provide training documentation in a form of video to Owner at time of completion, for future reference. Video to be taken at time of training and shall include operation of equipment, troubleshooting, setup and adjustments.

SECTION 43 21 13.21

VERTICAL NON-CLOG CENTRIFUGAL PUMPS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing variable speed vertical non-clog screw centrifugal pumps, complete with all accessories as indicated in accordance with the Contract Documents.

1.3 REFERENCES

- A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:
 - 1. American National Standards Institute (ANSI)
 - a. B16.1 – Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
 - 2. American Society of Mechanical Engineers (ASME)
 - 3. American Society for Testing and Materials (ASTM)
 - a. ASTM A48 - Standard Specification for Gray Iron Castings
 - 4. National Electrical Manufacturers Association (NEMA)

1.4 QUALITY ASSURANCE

- A. All equipment in this Section shall be furnished by or through a single supplier. The contractor shall be responsible for the design, coordination and proper operation of the entire system. Pumps shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer.
- B. The manufacturers shall be experienced in the design and construction of equipment for this purpose, and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than five (5) years.

C. WARRANTY

- a. The Contractor shall provide from the equipment manufacturer an extended warranty for a period of 12 months after acceptance of the equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

1.5 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:

WAS Pump No. 1
WAS Pump No. 2

1.6 SUBMITTALS

- A. Contractor shall submit shop drawings in accordance with General and Supplementary Conditions and Division 01.
- A. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.
- B. In addition to those submittals identified in the General and Supplementary Conditions and Division 01, the following items shall also be submitted:
 1. Performance data curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guarantee point.
 2. Catalog data on pumps, motors, and all appurtenances.
 3. Certified pump curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guarantee point.
 4. Installation or placing drawings for equipment, drives and bases.
 5. Suggested spare parts list with current price information.

6. List of special tools required for checking, testing, parts replacement, and maintenance. (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.)
7. List of materials and supplies furnished with the equipment.
8. Requirements for storage and protection prior to installation.
9. Requirements for routine maintenance required prior to plant startup.
10. Motor submittals shall include manufacturer's catalog information, motor drawings and operating characteristics, nameplate data and efficiency characteristics, and maximum starts per hour. Wiring diagrams shall be provided showing power and control wiring terminal connections including wiring identification and color coding. Junction box sizing for power and control wiring connections shall be provided. Information shall indicate compliance with requirements specified in the Section entitled "Miscellaneous Electric Motors."

C. Electrical Submittal Information

1. Submittals for equipment, control panel, and materials shall be clearly marked or noted with specific features, standard options, and wiring diagrams to indicate compliance with Contract Documents, Including terminal board wiring, diagrams including terminal numbers and conductor color codes for stator leads.
2. Where deviations to Contract Documents are proposed, submit a list of deviations. Provide a detailed description and explanation for each deviation.
3. Shop drawings shall present complete and accurate information relative to all working dimensions, equipment weights, assembly, and section views, and all necessary details pertaining to coordinating the Work of the Contract. Shop drawings shall contain information such as special tools and other items of information that are required to demonstrate detailed compliance with the Contract Documents.
4. Submit shop drawings, which shall include the following:
 - a. Bill of Materials for all equipment and accessories.
 - b. Manufacturer's catalog information for all components and accessories.
 - c. Manufacturer's standard wiring diagrams including all available terminal connections.
 - d. Project specific wiring interconnection diagrams showing all field termination points to remote equipment.
 - e. Spare Parts List (including specified spare parts to be furnished by the Contractor and manufacturer's recommended spare parts list for each type of unit).

- f. Project specific installation instructions and mounting details for each component. Materials of construction for supports, brackets, and mounting hardware shall be provided with details.
- D. Manufacturer's installation recommendations and instructions for the submersible, non-clog centrifugal pumps.
- E. Submit Operation and Maintenance Manuals in accordance with General and Supplementary Conditions and Division 01.
- F. Submit Manufacturer's certification that all materials furnished are in compliance with the applicable requirements of this Specification.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall store and protect equipment specified herein in accordance with the requirements of Division 01.
- B. After testing and before dismantling pumping equipment for shipment, all wiring and mechanical connections shall be match marked or tagged to ensure proper field assembly.
- C. Materials and equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Such boxes, crates or protection shall be clearly labeled with manufacturer's name, brand or model designation, and type or grade. Complete packing lists and bills for material shall be included with each shipment. Each item of equipment shall be tagged or marked with the same identification number or mark as shown on the packing lists and bills of material.
- D. Protect materials and equipment from exposure to the elements and keep dry at all times. Handle and store to prevent damage and in accordance with manufacturer's recommendations.
- E. Materials and equipment damaged by handling and storage shall be repaired or replaced by the Contractor as directed by the Engineer.
- F. Pumps shall be protected against corrosion during storage and prior to being placed in operation. Machined surfaces shall be flushed with heavy, noncorrosive oil, and bearing shall be lubricated. Contractor shall inspect the stored pump weekly, shall manually rotate or slide all moving parts, and shall renew the lubrication as necessary. Before the pump is put into operation, it shall be cleaned.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The project design is based on Hayward Gordon as listed in this Section.

- B. If any other manufacturer listed in this Section is proposed by the Contractor for the Work covered in this Section, it shall be the responsibility of the Contractor to perform any required redesign and coordination associated with, but not limited to, mechanical equipment layout, electrical wiring, conduit and controls, and structural/architectural work, at no additional cost to the Contract.
- C. No substitution of the listed manufacturer(s) will be allowed without prior approval by the Engineer, in accordance with the requirements outlined on the Bid Form.
- D. Acceptable manufacturers:
 - 1. Hayward Gordon
 - 2. Or approved equal

2.2 GENERAL

- A. Pumps shall be of the dry-pit, solids-handling, vertical screw-centrifugal type.

2.3 PERFORMANCE REQUIREMENTS

- A. General
Provide pumps with the following characteristics:

Pump configuration	Vertical, centrifugal
Type of impeller	Nonclog Screw Centrifugal
Liquid pumped	Activated Municipal Sludge
Percent solids	0 to 3% percent
Maximum sphere passage for WAS pump	3 inches
Suction conditions	Flooded
Drive	Vertical Variable Speed
Motor	Inverter Duty
Design	NEMA 4X
Duty:	Continuous, Ten starts per hour (minimum)
Insulation:	Class F
Service Factor:	1.15 (The motor service factor shall not be used in sizing the motors)
Nameplate voltage	460 volt, 3 ph, 60 Hz
- B. WAS Pumps

No. of pumps	2
Motor speed	1800 RPM (rated speed)
Pump	Shall be non-overloading throughout the pump curve
Design motor horsepower	5 HP
Max/Min Design Flows (gpm)	365/140
Max/Min Head (at Design Flows)	15.3 ft TDH / 10 ft TDH
Suction Size	4-inches
Discharge Size	4-inches
Minimum Sphere Passage	3 –inches

Seal

John Crane Type 1 Mechanical Seal (or approved equal).

2.4 MATERIALS AND CONSTRUCTION

A. Pump Casing

1. The casing shall be of cast iron ASTM A48 Class 30.
2. Pump castings shall be hydrostatically tested to two times design head or one and one-half times shutoff head, whichever is greater.
3. Volute shall have smooth fluid passages large enough to pass any size solid which can pass through the impeller.
4. A cleanout opening, with removable cover and interior surface matching the flow contour shall be located on the casing at the impeller centerline, to allow access to the interior of the impeller.
5. Casing shall be split perpendicular to the shaft, with removable suction cover and stuffing box cover.
6. Casing shall be arranged such that the impeller may be removed without disturbing either suction or discharge piping.
7. Suction and discharge connections shall have ANSI B16.1 flanges with Class 125 drilling pattern. Flange bolt holes shall be slotted for ease of assembly and disassembly.
8. The casing shall be provided with vent and drain connections.
9. Suction cone shall be removable to allow for access to the impeller.
10. Suction cone shall be constructed of High Chrome.
11. One piece suction cone, adjustable by shims, shall be of high chrome material and shall be a replaceable wear element.

B. Impeller

1. Impellers shall be High Chrome and shall be of the screw centrifugal type.
2. The design of the single passage impeller shall combine the action of a positive displacement screw and a single vane centrifugal impeller to provide a single non-bifurcated flowstream with only gradual changes in flow direction.
3. Impellers shall be statically and dynamically balanced.
4. The impeller flange shall incorporate a spiral groove to eject material from between the impeller and backplate.
5. The impeller shall be capable of passing solids of the maximum sphere size specified.
6. External adjustment shall be provided to maintain the bottom clearance between the impeller and suction cone.
7. Impellers shall have a tapered bore and shall be keyed and secured to the shaft by a stainless steel nut locked in place.

C. Shaft Seal

1. Stuffing box cover shall be constructed of cast iron with an integral stuffing box.

2. Seal shall be John Crane Type 1 Single mechanical seal or approved equal with SC faces. An integral seal housing/bearing frame design where failure of the secondary mechanical seal will allow contamination of the bearing housing is not acceptable.

D. Pump Shaft

1. The pump shaft shall be constructed of high strength carbon steel, AISI 4140 minimum.
2. The shaft shall be accurately machined, tapered at the impeller and of sufficient size to transmit full driver output.
3. Pump shaft shall be protected from the pumped liquid by 316 SS shaft sleeve, The shaft sleeve shall extend through the stuffing box and under the gland.
4. An O-ring seal shall be provided between the shaft and shaft sleeve to prevent leakage of pumped liquid out and/or air into the pump.

E. Pumping Bearing Frame

1. The pump bearing frame shall be of one-piece rigid cast-iron construction.
2. Frame shall be provided with a cast-iron bearing housing at the motor end and a cast iron end cover at the pump end.
3. The housing shall have filling and draining plugs.
4. Both ends of the frame shall be provided with lip-type grease seals and deflectors to prevent entrance of contaminants.
5. The bearing frame shall be designed so that the complete rotating element can be removed from the casing without disconnecting piping.
6. The outboard bearing housing shall exhibit no more than 4 mils peak deflection amplitude at any pump operating point measured in 3 different planes 90 degrees apart.

F. Bearing

1. Bearings shall be designed for 100,000 hours minimum B-10 life, as defined by the Anti-Friction Bearing Manufacturers Association, at conditions of operation.
2. Radial inboard bearings shall be a single row, roller type suitable for all loads encountered in the service conditions. Axial thrust outboard bearings shall be angular contact, double row ball type suitable for thrust loads in two directions.
3. Bearings shall be grease lubricated and provided with Zerk fittings.

G. Pump and Motor Base

1. The vertical base shall be cast iron or fabricated steel, with anchor bolt holes.
2. The base shall have openings large enough to permit access for grouting and maintenance of pump and driver. The base shall be designed for easy access to the handhole cleanout and such that the suction elbow can be removed for maintenance without having to remove or dismantle any of the pump components.
3. The base shall be designed to support the assembled weight of the pump, motor support, and motor.

4. The base shall safely withstand all stresses imposed thereon by vibration, shock and all possible direct and eccentric loads.
5. The base shall have adequate horizontal dimensions, foundation contact area, and anchorage facilities.
6. The pumping unit shall be factory mounted to the base.

H. Vent and Drain Connections

1. Provide tapped and plugged case vent and drain connection.
2. Field install a ½-inch petcock of stainless steel or bronze construction, rated for the case hydrostatic test pressure, in the casing vent connection.

I. Gauge Connections

1. Provide tapped and plugged suction and discharge gauge connections on the immediately adjacent piping.

J. Coupling

1. Coupling shall be flexible design and adjustable for direct coupled pumps.

K. Pump Drive Motors

1. Motors shall be capable of operation with PWM type variable frequency drives as specified in Section titled “Variable Frequency Controllers”.
2. Motors shall be TEFC vertical type, and shall conform to the requirements in Division 26 Electrical.
3. Provide motor anti-condensation heaters.
4. Motor shall be designed to accommodate thrust imparted by drive shaft load.

2.5 SHOP PAINTING

- A. With the exception of those parts and components customarily furnished unpainted, all metal surfaces shall be shop prepared and coated with rust inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified. Machined surfaces shall be protected against damage and corrosion by other means.
- B. Surface preparation and application of the shop paint coating shall be as specified in the Section entitled “Painting”.

2.6 SOURCE QUALITY CONTROL

- A. Perform shop testing in accordance with the requirements of the Section entitled “Tests on Pumping Equipment”.

2.7 SPARE PARTS

- A. Spare parts for the pumping equipment as listed below shall be provided in the quantities listed for each size of pump.
 - 1. One set of pump bearings
 - 2. One pump shaft sleeve.
 - 3. One impeller
 - 4. One suction cone or liner
 - 5. One set of motor bearings.
 - 6. One spare mechanical seal

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install pumps and accessories in accordance with the configuration shown on the Contract Drawings.
- B. Prior to grouting, pump and pump motor base plates shall be leveled with metal shims in accordance with Hydraulic Institute Standards. Wedges will not be allowed.
- C. The baseplates shall be grouted after initial fitting and alignment but before final bolting of connecting piping. The Contractor shall maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignments and bolting, pump connections shall be tested for applied stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.
- D. All bearings shall be lubricated according to the manufacturer's instructions and all adjustments made to suite anticipated operating conditions.

3.2 FIELD PAINTING

- A. Field painting shall be in accordance with the Section entitled "Painting".

3.3 FIELD TESTING

- A. Field inspection and testing of the pumps shall be performed in accordance with the Section entitled "Tests on Pumping Equipment".
- B. In addition to the tests required in the Section entitled "Tests on Pumping Equipment", the following field inspection and testing shall be performed:
 - 1. Pre-test Checkout
 - a. The Contractor shall demonstrate that each unit:
 - (1) Has not been damaged by transportation or installation.

- b. For each unit, the Contractor shall perform the following:
 - (1) Check for piping stresses after final alignment and bolting. Loosen flange bolts and measure pipe deflection or movement due to forcing pipe into position. If movement occurs, realign piping.
- c. Pump Prestart Checks
 - (1) Rotate each pump by hand to determine free rotation with motor leads disconnected.
 - (2) Briefly start each pump motor to determine if pump rotates in the correct direction.
 - (3) Demonstrate that all devices intended to start, stop and protect each pump will operate properly.
- d. Adjust, test and calibrate as required, all controls, switches, drive unit(s) and other instrumentation and control equipment associated with the equipment specified in this Section, followed by successful continued operation of each pump for minimum one hour, by pumping either process water or test water (potable or plant effluent).
- e. The System supplier shall have inspected the system, and certified proper installation and adjustments, either prior to or concurrent with the pre-test checkout.

2. Performance Test

- a. The Contractor shall perform the following:
 - (1) Demonstrate proper functioning pump suction and discharge pressure gauges.
 - (2) For VFD equipped pumps, operate pump at minimum capacity for one hour. Record pressures and motor amperage. If influent flow is greater than minimum pumping rate, increase pump speed, or bring additional pump(s) on-line to avoid wet well overflow.
 - (3) Operate pump at rated capacity (rated speed) for one hour. During the one hour test, record inlet and outlet pressures and motor amperage. Verify that specified discharge conditions at rated capacity are met. Quantification of discharge shall be through measurement of drawdown of the sludge collection wet well(s). Each pump shall be tested with return sludge. Record the following during the one hour test, at minimum 15 minute intervals:
 - (a) suction and discharge pump pressures.
 - (b) drawdown rate (time and change in wet well level) of the wet well with the pump being tested operating by itself (return sludge flow from the secondary clarifier

- into the wet well shall be turned off during drawdown timing).
- (c) discharge WAS flow (through the magnetic flow meter(s)).
 - (d) compare data from item (a) thru (d) with the certified pump performance curve.
- (4) Verify additional operating points on the certified pump performance curve by recording discharge rate and pressures for: 1) throttled conditions (partially close the pump discharge valve, or other downstream isolation valve), and 2) record pump shut-off pressures by closing the pump discharge valve (discharge rate is zero). Confirm with the pump manufacturer before conducting the shut-off test.
 - (5) For variable speed controlled pumps, repeat test item 4) only, for 50% and 75% speed, each 10 minutes total run time. Record from items 3a. thru 3d. once.
 - (6) Check vibration level on pump and motor for 4 mils maximum amplitude while operating at rated capacity.
 - (7) Measure noise levels at pump and motor with test instruments to verify that noise level is below 90 dba at a distance no further away than three feet from the unit.
 - (8) Verify that pump motors and bearings do not exhibit excessive heat rise.
- b. Automatic Pump Control

When all WAS pumps have been placed in service and tested according to the Performance Test 2.a., demonstrate, in AUTO mode, the following:

- (1) Based on a selected wet well setpoint level, operate the pumping system via the PID level controller.
- (2) Via the Secondary Clarifier Sludge Withdrawal Control Panel, gradually adjust the sludge pinch valve opening position. Verify changes in wet well level (bubbler control panel level read-out), and corresponding WAS pump output speed (output frequency) on the WAS pump VFD control panel.
- (3) Reduce the total WAS flow rate and increase the return sludge rate to the wet well. Verify wet well high level alarm.
- (4) Increase the WAS flow rate and close the sludge return valve. Verify wet well low level and pump shut-off.
- (5) Via the WAS Flow Balancing Control Panel, adjust the WAS flows to Aeration Basin Nos. 1, 2 and 3 to obtain equal flows (5% +/-).
- (6) Operate a balanced system for one hour. Record any adjustments necessary to maintain a balanced system.

3.4 MANUFACTURER'S FIELD SERVICE

- A. Provide manufacturer's services at the jobsite or classroom designated by the Owner for the minimum hours listed below, travel time excluded:

1. 16 hours for installation assistance, inspection, and certification of installation.
2. 16 hours for testing.
3. 8 hours for pre-startup classroom or job site training.

Each jobsite visit shall be scheduled separately with minimum seven (7) calendar days notice prior to each visit. The service visit for operational training shall be scheduled in coordination with the Owner's operations staff and shall be at such times as requested by the Owner.

- B. Above services shall be provided by the manufacturer's qualified factory-trained service staff.

END OF SECTION

SECTION 43 21 13.31.1

VERTICAL TURBINE SOLIDS HANDLING PUMPS EQUIPMENT INSTALLATION

PART 1- GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This specification includes the installation of three (3) single stage, Vertical Turbine Solids Handling (VTSH) Pumps supplied by the owner, each having size and discharge flow capacity characteristics as shown in Section 2.1.
- B. The pumps and motors shall be installed in the Primary Effluent Pump Station (PEPS) building to operate as a complete pumping system and integrated seamlessly with the pump controls, instrumentation, VFDs, wiring, flushing/seal water system, discharge valves, piping, pressure gauges, air release valves and all other related items
- C. Contractor shall install, test, startup, and commission all 3 pumps and ensure they are operating properly in accordance with these specifications and the pump manufacturer's requirements.

1.3 QUALITY ASSURANCE

A. GENERAL

- 1. The Contractor shall be responsible for ensuring that all equipment installed is properly connected to other related equipment for proper functioning of the plant.

B. WARRANTY

- 1. The Contractor shall provide from the equipment Manufacturer an extended warranty for a period of 12 months after acceptance of equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event that the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner. A new 12-month warranty for any replacement pump provided by the Manufacturer shall have the same stipulations as the original pump and begin upon acceptance of equipment by the Owner.

1.4 EQUIPMENT IDENTIFICATION

A. Equipment to be installed under this specification is identified as follows:

1. Primary Effluent Pump No. 1
2. Primary Effluent Pump No. 2
3. Primary Effluent Pump No. 3

1.5 RELATED WORK

A. Related sections include the following:

1. Division 9
 - a. Section "Painting"
2. Division 26
 - a. Section "Common Motor Requirements"
3. Division 40
 - a. Section "Pressure Gauges"
4. Division 40
 - a. Section "Tests on Pumping Equipment"

1.6 REFERENCES

A. The properties of all materials, design, fabrication and performance of the equipment to be installed under this section shall be in accordance with the latest issue of applicable standard specifications. The governing authorities of these standards are listed below.

1. AISC, American Institute of Steel Construction
2. AISI American Iron and Steel Institute
3. ANSI, American National Standards Institute
4. ASCE, American Society of Civil Engineers
5. ASME, American Society of Mechanical Engineers
6. ASTM, American Society of Testing and Materials
7. AWS, American Welding Society
8. IBC, International Building Code

9. IEC, International Electric Code
10. IEEE, Institute of Electrical and Electronics Engineers
11. NEC, National Electrical Code
12. NEMA, National Electrical Manufacturers Association
13. Underwriters Laboratory (UL and cUL)

1.7 SUBMITTALS

- A. Submittals shall conform to the General and Supplementary Conditions.
- B. Certifications:
 1. Certification of Proper Equipment Installation - Submit written certification by the VTSH pump supplier's representative of proper equipment installation following field inspection and prior to testing and startup.
 2. Certification of Equipment Testing and Startup - Submit written certification from the IFAS System supplier's representative verifying successful function testing.
- C. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Installing Contractor shall refer to Contract 1 Documents for Products supplied by the Owner / VTSH Pumps supplier.

PART 3 – EXECUTION

3.1 GENERAL

- A. The installation of the equipment furnished by the Owner (VTSH Pumps System Supplier Contract 1) shall be by the Installing Contractor.
- B. Installing Contractor shall refer to the Contract 1 shop drawings for manufacturer's installation instructions for equipment to be installed under this specification.

3.2 SCHEDULE

- A. The following summarizes the delivery and installation schedule requirements for Contract 1. The Installing Contractor shall coordinate his work accordingly to meet these deadlines.

Equipment Delivery Window: January 14, 2016 to October 29, 2016

Equip Installed & Ready to Test: January 13, 2017 to February 7, 2017

Initial Process Performance Testing Complete: April 7, 2017

Contract Complete: June 9, 2017

- B. If delivery to the jobsite of Owner furnished items is delayed through no fault of the Installation Contractor, the Installing Contractor shall be entitled to request a time extension equal to the number of work days from the originally scheduled delivery date to the date the items arrive to the jobsite. The Installing Contractor shall not be entitled to any additional compensation related to early or late delivery of items to be furnished by the Owner.
- C. The Installing Contractor shall notify the Owner as to when within the Equipment Delivery window the Contractor would like to receive the Contract 1 equipment at the jobsite. Notification shall be made a minimum 8 weeks prior to the start of the equipment delivery window.

3.3 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall store and protect equipment specified herein in accordance with the requirements of Division 01.
- B. The VTSH Pump System Supplier (Contract 1) will furnish and deliver all equipment, freight pre-paid, to the jobsite.
- C. Installing Contractor shall unload equipment furnished under Contract 1 at the jobsite.
- D. Installing Contractor shall protect materials and equipment from exposure to the elements and keep dry at all times. Handle, maintain and store to prevent damage and in accordance with manufacturer's recommendations.
- E. Refer to Contract 1 shop drawings for proper handling, maintenance and storage instructions.
- F. Material and equipment damaged by handling by the Installing Contractor shall be repaired or replaced by the Installing Contractor as directed by the Engineer at no additional cost to the Owner.

3.4 COMPONENT INSTALLATION AND FIELD TESTING

- A. Installing Contractor shall perform installation, testing, and startup of Contract 1 equipment.
- B. Refer to the following specification sections in the Contract Documents for installation, testing, and startup requirements for products supplied under Contract 1:
 - 1. “Electrically-Operated Primary Control Valves” for motor operated valves assemblies.
 - 2. “Pressure Gauges”
 - 3. “Instrumentation General” for field instrumentation.
 - 4. “Packaged System Control Panels” for VTSH Pump Control Panel and components.
- C. Refer to Contract 1 shop drawings for additional requirements for system component installation, inspection, testing, and startup.

3.5 VTSH PUMPS SYSTEM FIELD TESTING

- A. Installing Contractor shall perform field testing of the VTSH Pumps system after components have been installed and tested.
- B. VTSH Pumps System Manufacturer’s representative will provide field services as outlined in Contract 1. Installing Contractor shall be responsible for coordinating these field services.
- C. Refer to Contract 1 shop drawings, Section 9, for system inspection and start-up requirements. Please follow the VTSH Pump System manufacturer’s recommendations for instructions on completing the required documentation.

3.6 MANUFACTURER’S FIELD SERVICE

- A. The VTSH Pumps System Supplier will provide the services necessary to start-up, test, and operate the system as follows:
 - 1. Advice to Installing Contractor during installation
 - 2. Equipment check-out and start-up assistance
 - 3. Operator training
 - 4. Follow-up site visits
- B. Installing Contractor shall coordinate manufacturer’s field services with the Owner based on installation and startup schedule. The Installing Contractor shall provide the Owner / manufacturer 4 week’s notice to schedule any inspection or start-up trips.

3.7 FIELD PAINTING

- A. Field painting shall be by the Installing Contractor in accordance with the Section entitled "Painting." Refer to the Contract 1 shop drawings for any shop painting provided by the equipment manufacturer. Installing Contractor shall coordinate field painting as required.

* * * * *

SECTION 43 21 36.41

SCREW PUMPS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Furnish, install and start up equipment for the two (2) open screw pump assemblies and appurtenances as shown on the Drawings and/or described herein.
- B. The Contractor shall furnish and install all equipment and accessories and provide all necessary services for the equipment as specified herein. The scope of work shall include two (2) steel spiral flighted screws, along with upper and lower support bearings, deflection plates and miscellaneous appurtenances with their installation. The new screw and bearings shall work in conjunction with the existing drive motor, floor-mounted gear reducer, V-belts and sheaves, and automatic lower bearing lubrication system.
- C. New equipment will be installed on the existing upper drive base and lower bearing pedestal. Contractor shall design and modify the upper drive base and lower bearing pedestal, if required, in order to accommodate the screws and bearings being furnished.

1.3 QUALITY ASSURANCE

A. GENERAL

- 1. The Contractor shall be responsible for ensuring that all equipment installed is properly connected to other related equipment for proper functioning of the plant.

B. WARRANTY

- 1. The Contractor shall provide from the equipment Manufacturer an extended warranty for a period of 12 months after acceptance of equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event that the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

C. MANUFACTURER'S QUALIFICATIONS

1. The Manufacturer of work of this Section shall have five (5) years minimum proven experience in such work and shall have satisfactorily completed three (3) jobs of similar size and type within the last five (5) years .

1.4 EQUIPMENT IDENTIFICATION

A. Equipment covered in this section is identified as follows:

1. Influent Screw Pump No. 1
2. Influent Screw Pump No. 2

1.5 REFERENCES

- A. American Institute of Steel Construction (AISC)
- B. American Society of Testing and Materials (ASTM)
- C. American Society of Civil Engineers (ASCE)
- D. American Welding Society (AWS)
- E. Antifriction Bearing Manufacturers Association (AFBMA)
- F. Steel Structures Painting Council (SSPC)

1.6 SUBMITTALS

- A. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:
 1. All structural design calculations shall be prepared by the manufacturer and sealed by a professional engineer registered in the State of Ohio.
 2. Manufacturer's literature, illustrations, specification, and engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.
 3. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
 4. Operation and Maintenance manuals of the Screw Pumps.
 5. Contractor must field verify dimensions and elevations of existing screw pump troughs prior to shop drawing submittal.

- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other non-conformities.
- C. Submit Operations and Maintenance Manuals in accordance with the General and Supplementary Conditions.
- D. Submit Manufacturer's Certificate in accordance with the General and Supplementary Conditions.

1.7 STORAGE AND PROTECTION

- A. Store and protect the screw pumps and accessories in accordance with the requirements of Division 01.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. All of the equipment specified under this Section shall be furnished by a single supplier, who is fully experienced and qualified in the manufacture or supply of the equipment specified. The equipment shall be provided by one of the following Manufacturers:
 - 1. EPIC International Incorporated
 - 2. Evoqua Water Technologies
 - 3. Or approved equal.

2.2 DESIGN REQUIREMENTS

- A. Design requirements for the Influent Screw Pumps are as follows:

1.	Number of Pumps	2
2.	Pump Capacity, gal/min	21,861
3.	Lift, feet	20.5
4.	Pump Diameter, inches	96
5.	Maximum Number of Flights	3
6.	Minimum Flight Thickness, inches	0.315
7.	Torque Tube Diameter, inches	48
8.	Minimum Torque Tube Wall Thickness, inches	0.394
9.	Rotational Speed, rev/min	27

10.	Minimum Gear Reducer Torque Rating inch-LB	600,000
11.	Motor Size, hp	200
12.	Angle of Inclination	38°
13.	Maximum Deflection, inches	0.1875
14.	Minimum Pump Efficiency, %	76.3

2.3 SYSTEM COMPONENTS

A. SPIRAL SCREW

1. Spiral screw shall be fabricated of ASTM A36 steel. Each spiral screw shall have an outside diameter as noted in paragraph 2.2.A with the number of flights as noted in paragraph 2.2.A. Flights shall be die formed and shall have a minimum thickness as noted in paragraph 2.2.A. Flights shall be helical shaped and continuously welded on both sides of the torque tube. All flight butt welds shall also be continuously welded on both sides.
2. Each torque tube shall have a minimum diameter as noted in paragraph 2.2.A with a minimum wall thickness as noted in paragraph 2.2.A so the deflection of the torque tube shall be no greater than 3/16-inch. Calculations for stress and bearing loads shall be based on the dead weight of the flights and screw. Decreased loading from buoyancy effects and added stiffness due to the flights shall not be considered in the design calculations.
3. The torque tube shall be sealed watertight with a welded steel plate at each end. All surfaces of the end plates mating with the bolted stub shafts shall be finish machined while the pump is supported between centers in a lathe after welding to the support tube and after all flight welding is complete to assure alignment and parallelism.
4. A solid steel upper drive shaft and lower sleeve bearing and journal shall be fitted with machined, indexed flanges.
5. The screw shall be placed in a lathe and the flights shall be ground to a true radius.
6. Deflection of the screw pump shall not exceed 3/16-inch when calculated as a simple horizontal beam uniformly loaded with the dead load of the screw.
7. The leading edge of each flight shall be provided with steel reinforcement stiffeners from the torque tube to the outside diameter of the screw and shall be attached with continuous welds.
8. A flexible couple shall be provided to connect the upper shaft to the existing drive assembly. The coupling shall be designed with a 1.5 service factor based on the brake horsepower and shall be keyed and bored to suite the reducer slow speed shaft and the screw pump upper stub shaft. Guards meeting OSHA standards will be supplied with the coupling.

B. LOWER BEARING ASSEMBLY

1. The lower bearing assembly shall include a heavy weight cast iron base with anchor bolt holes as shown on the Drawings. Bolted to the base shall be a machined ductile iron journal at the angle specified in paragraph 2.2.A. The journal shall receive the bronze sleeve bearing that is fastened to the lower end plate.
2. The bronze sleeve shall have a ratio of the length of the sleeve bearing to the diameter of the sleeve bearing not to exceed 1.5:1. The load pressure generated by the screw pump body, acting on the sleeve bearing shall not exceed 175 psi. The bronze bushing shall incorporate a “figure eight” or “double figure eight” interlocked grease access passageway to promote consistent grease disbursement across the entire bearing surface. Bronze bushings which use straight passageways that do not interconnect will not be accepted for this project.
3. The center axis of the journal shall be hollow to serve as the grease access port for the lower bearing. The grease shall enter the lower bearing on the opposite end of the bronze bushing that grease exits the bearing, thereby forcing grease across the entire bronze bushing. Bearing assembly shall accommodate all static and operating deflections of the screw.
4. Bearing assemblies shall be supplied with a split non-rotating shield installed on the fixed journal side of the bearing.
5. The bearing assembly shall accommodate thermal expansion and contraction of the screw within the bearing housing on fully lubricated surfaces not subject to corrosion or seizure.
6. The bearing assembly must be removable for maintenance purposes without disturbing the screw pump body. To ensure proper installation, the bearing must include a machined index fit.
7. The use of roller or ball bearings will not be acceptable. The lower bearing shall carry no thrust load.
8. The bearing assembly shall be fully self-aligning (in all three {3} planes).

C. UPPER BEARING ASSEMBLY

1. The upper stub shaft shall extend through a grease lubricated upper bearing assembly which shall consist of a split housing fitted with dual bearings, lower spring loaded lip seal, bearing spacer and upper spring loaded lip seal.
2. All of the thrust load from the pump shall be carried by a spherical roller thrust-type bearing assembly and the upper screw pump radial load shall be carried by a spherical roller bearing. A single dual-purpose bearing will not be acceptable.

3. The two bearings (radial and thrust) shall be positioned in the bearing housing so that the pressure center of the thrust bearing and radial bearing intersects the axis of the screw at the same point to provide true self-alignment in all planes.
4. Upper stub shaft shall be threaded to accept a lock nut, which will transfer the thrust load from the shaft to the upper bearing. The means of fastening the stub shaft to the upper bearing must permit assembly and disassembly in the field. The use of grooves and split locking collars which are not field replaceable will not be accepted for this project.
5. Both radial and thrust bearings shall be rated at a minimum of 200,000 hours AFBMA L10 theoretical design life, based on the dead weight of the screw.
6. A split bearing housing shall be provided to allow removal of the cover for inspection of the bearings without removal of the stub shaft or the entire bearing assembly.
7. The bearing shall be fully self-aligning (in all three {3} planes).

D. DEFLECTION PLATES

1. A flow deflection plate shall be provided to curve around the upper section on the uptake side of the screw to deflect the liquid as the screw rotates.
2. The flow deflection plate shall be fabricated of not less than 4 mm 304 stainless steel plate complete with stiffeners where required and stainless steel anchors at not more than 2 foot centers at the bottom edge.
3. The deflection plate top edge shall have adjustable anchors at not more than 8 foot centers.

E. AUTOMATIC LUBRICATION SYSTEM

1. 3/8 inch minimum diameter stainless steel grease lines shall be furnished and installed for each screw pump to connect the existing positive pressure, automatic lubrication pumps to the lower bearing assemblies. Excess grease from the lower bearing assemblies shall be returned through the grease lines to new stainless steel container reservoirs which are to be located in the Screw Pump Drive House. The excess grease stainless steel reservoirs shall be furnished by the Manufacturer and installed by the Contractor. The grease lines shall be securely fastened in place at regular intervals throughout its length to prevent movement.
2. The existing automatic lubrication pumps shall provide grease lubricant to the lower bearing assemblies.

F. GROUTING MATERIALS

1. Equipment manufacturer shall furnish a radius screed for the Contractor to place the finishing grout in the trough with the screw.

2. Equipment manufacturer shall loan to the CONTRACTOR additional sheave(s) and belts as required to operate the screw at a reduced speed for grouting the trough with the screw pump drive.

G. ANCHOR BOLTS

1. Equipment manufacturer shall furnish all anchor bolts of ample size and strength required to securely anchor each item of equipment. Anchor bolts, hex nuts, and washers shall be 304 stainless steel unless noted otherwise. Anchor bolts shall be L-type embedded. Expansion-type anchors will not be acceptable.
2. Anchor bolts shall be set by the Contractor. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

2.4. SHOP SURFACE PREPARATION AND PAINTING

- A. All fabricated carbon steel or cast iron components for submerged service shall be solvent-cleaned SSPC-SP1 followed by a near-white blast cleaning SSPC-SP10 and given a 3 mil dry film thickness coat of Tnemec 66 Hi-Build Epoxoline Primer.
- B. All fabricated carbon steel or cast iron components for non-submerged service shall be solvent-cleaned SSPC-SP1 followed by a commercial blast cleaning SSPC-SP6 and given a 3 mil dry film thickness coat of Tnemec 66 Hi-Build Epoxoline Primer.
- C. Enclosed components shall be supplied with the manufacturer's standard finish coating.
- D. Apply rust preventative compound to all machined, polished, and nonferrous surfaces which are not to be painted.
- E. Finish painting shall be performed at the factory and before shipment in accordance with Section 09 91 00, Painting.
- F. The Contractor shall touch-up all shipping damage to the paint as soon as the equipment arrives on the job site.
- G. Prior to the assembly all stainless steel bolts and nut threads shall be coated with a non-seizing compound by the Contractor.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. The equipment furnished under this section shall be tested for deflection, balanced, and have all finish coats applied at the factory in accordance with Section 09 91 00 prior to shipment to the site. One representative each of the owner, engineer, and manufacturer may review and inspect the welding, fabrication, deflection calculations, and finish

painting of all of the screw pumps furnished under this section prior to shipment from the factory to the site.

- B. The manufacturer shall schedule two (2) trips to the project site for start-up assistance and inspection of installed equipment for proper operation.
- C. After the Contractor has installed the equipment and the units are capable of being operated, the equipment manufacturer shall furnish a qualified representative for a minimum of three (3) man-days (up to 24 hours) to inspect the equipment and to supervise field testing and startup for the Contractor.

3.2 OPERATOR TRAINING

- A. Provide operator training for Owner's personnel after the system is operational. Training shall take place while manufacturer's representative is at the job site for equipment inspection.

* * * * *

SECTION 43 21 39.11

SUBMERSIBLE NON-CLOG CENTRIFUGAL PUMPS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for providing submersible non-clog centrifugal pumps and appurtenances, complete with pump control panel, float switches and all accessories and appurtenances as shown on the Contract Drawings.

1.3 QUALITY ASSURANCE

- A. All equipment in this Section shall be furnished by or through a single supplier. The contractor shall be responsible for the design, coordination and proper operation of the entire system. Pumps shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer.

- B. The manufacturers shall be experienced in the design and construction of equipment for this purpose, and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than five (5) years.

C. WARRANTY

- a. The Contractor shall provide from the equipment manufacturer an extended warranty for a period of 12 months after acceptance of the equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

1.4 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:

Internal Recycle Pump No. 1a
Internal Recycle Pump No. 1b
Internal Recycle Pump No. 2a
Internal Recycle Pump No. 2b
Internal Recycle Pump No. 3a

Internal Recycle Pump No. 3b
Internal Recycle Pump No. 4
Internal Recycle Pump No. 5
Internal Recycle Pump No. 6

1.5 SUBMITTALS

- A. Contractor shall submit shop drawings in accordance with General and Supplementary Conditions and Division 01.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.
- C. In addition to those submittals identified in the General and Supplementary Conditions and Division 01, the following items shall also be submitted:
 - 1. Performance data curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guarantee point.
 - 2. Catalog data on pumps, motors, and all appurtenances.
 - 3. Certified pump curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guarantee point.
 - 4. Installation or placing drawings for equipment, drives and bases.
 - 5. Suggested spare parts list with current price information.
 - 6. List of special tools required for checking, testing, parts replacement, and maintenance. (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.)
 - 7. List of materials and supplies furnished with the equipment.
 - 8. Requirements for storage and protection prior to installation.
 - 9. Requirements for routine maintenance required prior to plant startup.
 - 10. Motor submittals shall include manufacturer's catalog information, motor drawings and operating characteristics, nameplate data and efficiency characteristics, and maximum starts per hour. Wiring diagrams shall be provided showing power and control wiring terminal connections including

wiring identification and color coding. Junction box sizing for power and control wiring connections shall be provided. Information shall indicate compliance with requirements specified in the Section entitled "Miscellaneous Electric Motors."

D. Electrical Submittal Information

1. Submittals for equipment, control panel, and materials shall be clearly marked or noted with specific features, standard options, and wiring diagrams to indicate compliance with Contract Documents, Including terminal board wiring, diagrams including terminal numbers and conductor color codes for stator leads.
2. Where deviations to Contract Documents are proposed, submit a list of deviations. Provide a detailed description and explanation for each deviation.
3. Shop drawings shall present complete and accurate information relative to all working dimensions, equipment weights, assembly, and section views, and all necessary details pertaining to coordinating the Work of the Contract. Shop drawings shall contain information such as special tools and other items of information that are required to demonstrate detailed compliance with the Contract Documents.
4. Submit shop drawings, which shall include the following:
 - a. Bill of Materials for all equipment and accessories.
 - b. Manufacturer's catalog information for all components and accessories.
 - c. Manufacturer's standard wiring diagrams including all available terminal connections.
 - d. Project specific wiring interconnection diagrams showing all field termination points to remote equipment.
 - e. Spare Parts List (including specified spare parts to be furnished by the Contractor and manufacturer's recommended spare parts list for each type of unit).
 - f. Project specific installation instructions and mounting details for each component. Materials of construction for supports, brackets, and mounting hardware shall be provided with details.

- E. Manufacturer's installation recommendations and instructions for the submersible, non-clog centrifugal pumps.
- F. Submit Operation and Maintenance Manuals in accordance with General and Supplementary Conditions and Division 01.
- G. Submit Manufacturer's certification that all materials furnished are in compliance with the applicable requirements of this Specification.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Contractor shall store and protect equipment specified herein in accordance with the requirements of Division 01.
- B. After testing and before dismantling pumping equipment for shipment, all wiring and mechanical connections shall be match marked or tagged to ensure proper field assembly.
- C. Materials and equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Such boxes, crates or protection shall be clearly labeled with manufacturer's name, brand or model designation, and type or grade. Complete packing lists and bills for material shall be included with each shipment. Each item of equipment shall be tagged or marked with the same identification number or mark as shown on the packing lists and bills of material.
- D. Protect materials and equipment from exposure to the elements and keep dry at all times. Handle and store to prevent damage and in accordance with manufacturer's recommendations.
- E. Materials and equipment damaged by handling and storage shall be repaired or replaced by the Contractor as directed by the Engineer.
- F. Pumps shall be protected against corrosion during storage and prior to being placed in operation. Machined surfaces shall be flushed with heavy, noncorrosive oil, and bearing shall be lubricated. Contractor shall inspect the stored pump weekly, shall manually rotate or slide all moving parts, and shall renew the lubrication as necessary. Before the pump is put into operation, it shall be cleaned.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND SYSTEM SUPPLIERS

- A. If any other manufacturer other than those listed in this Section is proposed by the Contractor for the Work covered in this Section, it shall be the responsibility of the Contractor to perform any required redesign and coordination associated with, but not limited to, mechanical equipment layout, electrical wiring, conduit and controls, and structural/architectural work, at no additional cost to the Contract.
- B. No substitution of the listed manufacturer(s) will be allowed without prior approval by the Engineer, in accordance with the requirements outlined on the Bid Form.
- C. Acceptable manufacturers:
 - 1. Flowserve
 - 2. ABS
 - 3. KSB
 - 4. Or approved equal

2.2 GENERAL

- A. Pumps shall be of the wet-pit, submersible, solid-handling, vertical centrifugal type.

Pumps shall be capable of pumping raw, unscreened wastewater, and shall be capable of passing diameter spherical solids as listed in the section entitled "Performance Requirements" below.

- B. Pumps shall be specifically designed for continuous duty operation in a submerged pump application. The pumps shall not overload the motors at any point on the pump performance curve within the operating limits recommended by the pump manufacturer.
- C. The pump, with its appurtenances and cable, shall be capable of continuous submergence without loss of water tight integrity to a depth of 30 feet.

2.3 PERFORMANCE REQUIREMENTS

A. IR Pumps

No. of pumps	9
Pump configuration	Submersible, centrifugal
Design Point @ rated speed:	5,625 gpm @ 24.5 ft TDH
Pump Discharge Diameter:	12"
Type of impeller	Radial Nonclog
Liquid pumped	IFAS IR Well
Suction conditions	Flooded
Percent solids	0 to 2 percent
Minimum sphere passage	3 inches
Maximum pump speed	1200 RPM (rated speed)
Maximum pump weight	2000 lbs
Motor Horsepower:	30 HP
Drive Type:	Variable Frequency
Motor Type:	Submersible, Squirrel Cage, inverter duty
Nominal Motor Speed:	Coordinate with Pump RPM Requirements
Motor Efficiency:	Premium Efficient
Design:	NEMA Design B
Duty:	Continuous, Ten starts per hour (minimum)
Insulation:	Class F
Voltage:	460V, 3 Ph., 60 Hz.
Service Factor:	1.15 (The motor service factor shall not be used in sizing the motors)
Motor Enclosure:	Submersible, housed in an air-filled or oil-filled, watertight chamber. Cast Iron Construction
Protection:	Integral Motor Winding Thermostats & Seal Fail Sensors

2.4 MATERIALS AND CONSTRUCTION

A. GENERAL

1. Where water tight sealing is required, O-rings made of BUNA shall be used.

All mating surfaces where water tight sealing is required shall be such that sealing is accomplished by metal to metal contact between machined surfaces, resulting in a controlled compression of BUNA O-rings without the requirement of a specific torque limit to affect the seal. No rectangular gaskets, elliptical "O"-rings, grease, or other devices shall be used.

2. Design pumps to allow for removal and reinstallation without the need to enter the wet well and without removal of bolts, nuts or other fasteners.
3. Provide a pump which connects to a permanently mounted discharge connection by simple downward motion, without rotation, guided by at least guide bars extending from the top of the station to the discharge connection. The use of guide cables is not acceptable. Final connection shall insure zero leakage between pump and discharge connection flange and shall be accomplished by a machined metal to metal or gasketed watertight contact.
4. Provide a discharge connection/guide system so that no part of the pump bears directly on the floor of the wet well.
5. Provide Type 316 stainless steel chain or cable of sufficient length to properly and safely lift pumps from the wet well.
6. Furnish major components (pump case, impeller, intermediate housing, motor housing) of cast material as specified with smooth surfaces devoid of blow holes and other irregularities.
7. All major castings shall be produced in the pump manufacturer's own foundry, under the manufacturer's direct supervision.
8. All mounting hardware shall be stainless steel. All exposed nuts and bolts shall be of AISI Type 304 stainless steel construction. All surfaces coming into contact with sewage, other than stainless steel or bronze, shall be protected by an approved sewage resistant coating.

B. IMPELLER AND WEAR RINGS

1. Provide non-clog type impeller, capable of passing at minimum diameter spherical solid as indicated in the "Performance Requirements" section above.
2. Statically and dynamically balance the impeller.
3. Provide hard metal wear rings on case of material and Brinell hardness so as to ensure maximum pump/impeller life and continuing high efficiencies. Replaceable insert rings are also acceptable.
4. The use of soft metals (i.e. bronze, 304 or 316 stainless) or elastomers as wear ring material is incompatible with the grit contaminate expected in the pumpage and will therefore be strictly prohibited.

C. SHAFT

1. Provide common pump/motor shaft of sufficient size to transmit full driver output with a maximum deflection of 0.002 inches measured at the lower mechanical seal.
2. The pump shaft shall be AISI type 431 or 416 stainless steel.
3. The use of carbon steel as shaft material shall be strictly prohibited.

D. SHAFT SEAL

1. Provide two totally independent mechanical shaft seals, installed in tandem, each with its own independent spring system acting in a common direction.
1. Install the upper seal in an oil-filled chamber with drain and inspection plug (with positive anti-leak seal) for easy access from external to the pump.
3. Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced.
4. Provide seals, which are non-proprietary in design, with replacements available from a source other than the pump manufacturer.
5. Do not provide seals with the following characteristics: Conventional double mechanical seals with single or multiple springs acting in opposed direction; cartridge-type mechanical seals; seals with face materials other than those specified; seals using the impeller hub as a mounting surface.
6. Seal faces shall be silicon carbide vs. silicon carbide for both the upper and lower seals.

E. BEARINGS

1. Furnish upper and lower bearings, to provide a B10 life of, at minimum, 100,000 hours at anticipated axial and radial loadings.
2. Provide either sealed/shielded (permanently lubricated) or open (regreasable) bearings.
3. If open-type (non-shielded) bearings are used, provide re-lubrication ports with positive anti-leak plugs for periodic addition of lubrication from external to the pump.

E. MOTOR

1. Motors shall be capable of supplying the maximum rated horsepower and rpm at the conditions and within the ranges scheduled and shall be capable of withstanding all forces which may be imposed during the course of normal operation.

2. Provide adequately rated motor with sufficient surface area for ambient cooling.
3. Provide motors which are capable of operating for extended periods in a dry mode without damage to motor or seals.
4. Provide motors which are designed, rated and warranted for continuous operation.
5. Do not provide motors which contain in excess of three (3) gallons of oil (combined total for cooling and seals), or which contain other than ecologically safe paraffin base oil.
6. Protective Devices
 - a. The motor shall be furnished with protective devices as normally provided by the pump manufacturer. The motor protective devices shall be compatible with the pump control and status monitor specified below. The temperature ranges, set points, and activation levels shall be as recommended by the pump manufacturer.
 - b. Motor protective devices shall include the following:
 - (1) The motor shall be provided with thermal sensors installed in the motor windings to monitor the motor temperature.
 - (2) Leakage sensor shall be located in the cooling jacket/barrier fluid and be a moisture sensor probe.
 - c. The thermal sensors and float switch leakage sensor shall be connected in series and coupled to the control circuit of the control panel so as to shut the motor down. The sensors shall be factory installed and wired, and the leads shall be connected to the pump power and control cable.
7. The cable entry shall be an integral part of the stator casing. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak-proof, torque free seal at the cable entrance. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a brass gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion.
8. Each pump shall include an electric power and control cable of the length required for the installation shown on the Contract Drawings plus an additional 10' length for maintenance purposes. The power and control cable shall be resistant to oil, corrosive gases and other materials normally found in sewage service. The cable entry into the motor shall include a sealing by a close

tolerance elastomer grommet flanked by stainless steel washers. The cable shall terminate in a sealed junction chamber with a terminal board or terminal block. Power cable sizing shall conform to NEC/IPCEA standards for motors. Motor protective device circuit conductors shall be included in the cable.

9. Provide stainless steel cable grips (strain reliefs) as required to support each cable.

2.4 SHOP PAINTING

- A. With the exception of those parts and components customarily furnished unpainted, all metal surfaces shall be shop prepared and coated with rust inhibitive shop paint. Shop paint shall be fully compatible with the field paint specified. Machined surfaces shall be protected against damage and corrosion by other means.
- B. Surface preparation and application of the shop paint coating shall be as specified in the Section entitled "Painting."

2.5 SOURCE QUALITY CONTROL

- A. Perform shop testing in accordance with the requirements of the Section entitled "Tests on Pumping Equipment."

2.6 SPARE PARTS

- A. At minimum, spare parts for the pumping equipment shall be provided to do one pump rebuild, and include at least the items as listed below in the quantities listed for each size of pump.
 1. One impeller with wear ring attached.
 2. One set of impeller and case wear rings with screws.
 3. One set of motor bearings.
 4. One set mechanical seals.
 5. One Quart of extra oil per pump
- B. Packaging and Labeling

Spare parts listed to be furnished shall be packed in wooden boxes, labeled with the manufacturer's name, address and telephone number; local representative's name, address and telephone number; name of equipment the parts are for and list of parts contained therein.

2.7 PUMP MOTOR INTERFACE CONTROLS

- A. General
 1. The pump manufacturer shall furnish special controls specifically required for interfacing with the pump motor protective devices specified above. The pump manufacturer shall furnish the required controls to be installed in each Pump Station Control Panel.

B. Pump Control and Status Monitor

1. Each pump shall be provided with a self-contained control and status monitor designed for use with the motor protective devices provided. The unit shall monitor stator temperature and leak detection. In the event of an alarm condition, the monitor shall provide relay output control interlocks and alarms to provide control functions as shown on the Contract Drawings.
2. The monitor shall be provided with the following features;
 - a. Supply Voltage: 24 VAC
 - b. Input Channel: Monitors high temperature and leakage conditions.
 - c. Output Relays: Common alarm output relay
Alarm interlock output relay
Contacts rated 8 amperes at 120 VAC.
 - d. Status LEDs: Yellow for supply voltage presence
Red for Overtemperature Indication
Red for Leakage Indication
 - e. Alarm Reset: Manual reset input channel
 - f. Mounting: Suitable for 11 pin relay socket mounting.
3. Wiring connections for control and status monitor shall be as shown on the Contract Drawings and as recommended by the pump manufacturer.
4. The monitor shall be configured by the pump manufacturer prior to startup of each pump.

C. Spare Parts

1. Provide three spare pump control and status monitors to the CSI, who shall turn them over to the Owner.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install pumps and accessories in accordance with the configuration shown on the Contract Drawings.
- B. Prior to grouting, pump and pump motor base plates shall be leveled with metal shims in accordance with Hydraulic Institute Standards. Wedges will not be allowed.
- C. The baseplates shall be grouted after initial fitting and alignment but before final bolting of connecting piping. The Contractor shall maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignments and bolting, pump connections shall be tested for applied stresses by

loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

- D. All bearings shall be lubricated according to the manufacturer's instructions and all adjustments made to suite anticipated operating conditions.

3.2 FIELD PAINTING

- A. Field painting shall be in accordance with the Section entitled "Painting."

3.3 FIELD TESTING

- A. Field inspection and testing of the pumps shall be performed in accordance with the Section entitled "Tests on Pumping Equipment."

- B. In addition to the tests required in the entitled "Tests on Pumping Equipment", the following field inspection and testing shall be performed:

- 1. Pre-test Checkout

- a. The Contractor shall demonstrate that each unit:

- (1) Has not been damaged by transportation or installation.

- b. For each unit, the Contractor shall perform the following:

- (1) Check for piping stresses after final alignment and bolting. Loosen flange bolts and measure pipe deflection or movement due to forcing pipe into position. If movement occurs, realign piping.

- c. Pump Prestart Checks

- (1) Rotate each pump by hand to determine free rotation with motor leads disconnected.

- (2) Briefly start each pump motor to determine if pump rotates in the correct direction.

- (3) Demonstrate that all devices intended to start, stop and protect each pump will operate properly.

- d. Adjust, test and calibrate as required, all controls, switches, drive unit(s) and other instrumentation and control equipment associated with the equipment specified in this Section, followed by successful continued operation of each pump for minimum one hour, by pumping either process water or test water (potable or plant effluent).

- e. The System supplier shall have inspected the system, and certified proper installation and adjustments, either prior to or concurrent with

the pre-test checkout.

2. Performance Test

Perform pump running tests in accordance with the section entitled “Test on Pumping Equipment”.

3.4 MANUFACTURER’S FIELD SERVICE

A. Provide manufacturer's services at the jobsite or classroom designated by the Owner for the minimum hours listed below, travel time excluded:

1. 8 hours for installation assistance, inspection, and certification of installation.
2. 8 hours for testing.
3. 4 hours for pre-startup classroom or job site training

* * * * *

SECTION 43 21 39.23

SUBMERSIBLE RECIRCULATOR CHOPPER PUMPS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- B. This Section includes requirements for providing submersible recirculator chopper pumps, complete with all accessories and appurtenances as indicated in accordance with the Contract Documents.

1.3 REFERENCES

- A. All materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein.
 - 1. National Electric Code (NEC)
 - 2. National Electric Manufacturers Association (NEMA)
 - 3. Underwriters Laboratories, Inc. (UL)
 - 4. American National Standard Institute (ANSI)
 - 5. Occupational Health and Safety Administration (OSHA)

1.4 QUALITY ASSURANCE

- A. All equipment in this Section shall be furnished by or through a single supplier. The contractor shall be responsible for the design, coordination and proper operation of the entire system. Pumps shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer.

- B. The manufacturers shall be experienced in the design and construction of equipment for this purpose, and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than five (5) years.

C. WARRANTY

- a. The Contractor shall provide from the equipment manufacturer an extended warranty for a period of 12 months after acceptance of the equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the

extended warranty. In the event the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

1.5 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:

IFAS Scum Pump No. 1
IFAS Scum Pump No. 2
Shelf spare

1.6 SUBMITTALS

- A. Contractor shall submit shop drawings in accordance with General and Supplementary Conditions and Division 01.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.
- C. In addition to those submittals identified in the General and Supplementary Conditions and Division 01, the following items shall also be submitted:
1. Performance data curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guarantee point.
 2. Catalog data on pumps, motors, and all appurtenances.
 3. Certified pump curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guarantee point.
 4. Installation or placing drawings for equipment, drives and bases.
 5. Suggested spare parts list with current price information.
 6. List of special tools required for checking, testing, parts replacement, and maintenance. (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.)
 7. List of materials and supplies furnished with the equipment.

8. Requirements for storage and protection prior to installation.
9. Requirements for routine maintenance required prior to plant startup.
10. Motor submittals shall include manufacturer's catalog information, motor drawings and operating characteristics, nameplate data and efficiency characteristics, and maximum starts per hour. Wiring diagrams shall be provided showing power and control wiring terminal connections including wiring identification and color coding. Junction box sizing for power and control wiring connections shall be provided. Information shall indicate compliance with requirements specified in the Section entitled "Miscellaneous Electric Motors."

A. Electrical Submittal Information

1. Submittals for equipment, control panel, and materials shall be clearly marked or noted with specific features, standard options, and wiring diagrams to indicate compliance with Contract Documents, Including terminal board wiring, diagrams including terminal numbers and conductor color codes for stator leads.
2. Where deviations to Contract Documents are proposed, submit a list of deviations. Provide a detailed description and explanation for each deviation.
3. Shop drawings shall present complete and accurate information relative to all working dimensions, equipment weights, assembly, and section views, and all necessary details pertaining to coordinating the Work of the Contract. Shop drawings shall contain information such as special tools and other items of information that are required to demonstrate detailed compliance with the Contract Documents.
4. Submit shop drawings, which shall include the following:
 - a. Bill of Materials for all equipment and accessories.
 - b. Manufacturer's catalog information for all components and accessories.
 - c. Manufacturer's standard wiring diagrams including all available terminal connections.
 - d. Project specific wiring interconnection diagrams showing all field termination points to remote equipment.
 - e. Spare Parts List (including specified spare parts to be furnished by the Contractor and manufacturer's recommended spare parts list for each type of unit).
 - f. Project specific installation instructions and mounting details for each component. Materials of construction for supports, brackets, and mounting hardware shall be provided with details.

B. Manufacturer's installation recommendations and instructions for the submersible, non-clog centrifugal pumps.

- C. Submit Operation and Maintenance Manuals in accordance with General and Supplementary Conditions and Division 01.
- D. Submit Manufacturer's certification that all materials furnished are in compliance with the applicable requirements of this Specification.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND SYSTEM SUPPLIERS

- A. The project design is based on Vaughan Co. as listed in this Section.
- B. If any other manufacturer listed in this Section is proposed by the Contractor for the Work covered in this Section, it shall be the responsibility of the Contractor to perform any required redesign and coordination associated with, but not limited to, mechanical equipment layout, electrical wiring, conduit and controls, and structural/architectural work, at no additional cost to the Contract.
- C. No substitution of the listed manufacturer(s) will be allowed without prior approval by the Engineer, in accordance with the requirements outlined on the Bid Form.
- D. Acceptable manufacturers:
 - 1. Vaughan Co., Inc. (Model S4KR-075)
 - 2. Hayward-Gordon (Model ChopX4A-S)
 - 3. Or approved equal

2.2 GENERAL

- A. The submersible recirculator chopper pump shall be specifically designed to mix and pump scum, grease and other floatables from the IFAS Effluent Channel without plugging. Materials shall be chopped/macerated and conditioned by the pump as an integral part of the pumping action. The pump must have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications. All equals shall provide at least 3 references of the same style pump and the same application, and shall have at least 3 years prior experience with the same style pump in the same application. Pumps with fabricated impeller, cutter bar or casing shall not be acceptable.

2.3 PERFORMANCE REQUIREMENTS

- A. IFAS Scum Pumps

No. Required	3 (2 installed, 1 spare)
Type	Submersible, Chopper, Recirculating
Rated Speed	1200 rpm
Seals	Mechanical
Materials	As specified

Operating conditions at rated speed:

	Flow (gpm)	TDH (ft)	Pump Eff. (Min)
Design Points:	380	13	35%
	260	16	35%

B. Motor Parameters:

Motor Horsepower:	5 Hp Maximum
Motor Type:	3-Phase Squirrel Cage Induction
Nominal Motor Speed:	Coordinate with Pump RPM Requirements
Motor Efficiency:	Premium Efficient
Design:	NEMA Design B
Duty:	Continuous
Insulation:	Class H
Voltage:	460V, 3 Ph., 60 Hz.
Service Factor:	1.15
Motor Enclosure:	Submersible
Protection:	Integral Motor Winding Temperature Switch and Moisture Sensing Probe

2.4 MATERIALS AND CONSTRUCTION

A. Submersible Pump Motors

1. Each motor shall meet the criteria presented in the applicable portions of this specification. Motors supplied for application with submersible pumps shall be specifically designed to drive the units. They shall be non-overloading within the pumping range shown on the head/capacity curve for the specific pump impeller utilized. Pump shall not require motor to operate in the service factor range at any operating point on the pump curve.
2. Performance: The motors shall be capable of supplying the maximum rated horsepower and rpm at the conditions and within the ranges specified in the "Performance Requirements" of this specification.
3. Motors shall have NEMA Design B torque characteristics and Class F insulation. Motors shall be rated for continuous duty in 25° C liquid, and for 15 minutes in air, without overheating.
5. Motor hardware and shafting shall be stainless steel. Inspection plugs shall be provided in the stator housing to determine the condition of the upper seal assembly as well as to discover any other leakage into the housing without disassembly.
6. Protection
 - a. Motor shall be equipped with tandem mechanical seals in oil bath.
 - b. Motors shall include a moisture sensing probe within the stator housing to sense a seal leak. A moisture sensing control relay shall be provided for the pump, which shall be wired into the motor control

circuit for the pump. The moisture sensing relay shall shut down the motor before the liquid level reaches the stator end coils to prevent motor burnout.

- c. Motors shall include automatic reset winding temperature switches to protect against overheating. Thermal sensors shall automatically reset when motor winding drops below actuation temperature.
- d. The moisture sensing and winding temperature protection relay for each pump shall be installed in the Scum Pump Control Panel.

B. Pump Motor Power and Control Cables

- 1. The pump motor electrical power and auxiliary control cables shall be type SOOW. Cable sizing shall conform to NEC/IPCEA standards for motors and shall be sized for use with the motor provided. Cables shall be provided in sufficient length to be installed between motors and the pump control panel without splices. The auxiliary control cable shall be provided for use with the motor winding thermal sensors and stator housing moisture sensor. Cables shall be provided with conductors as required to furnish power and monitor failure signals of the pump motor. Cables shall be adequately supported.
- 2. Electrical cable entry water seal design for connection to motor shall be provided with a watertight and submersible seal, without specific torque requirements.

C. Hoists

Hoisting equipment shall be provided for equipment removal in accordance with the Section entitled "Hoisting Equipment". The pump manufacturer shall coordinate pump load chain configuration and total weight of the removable pump assembly in accordance with hoisting equipment configuration and load capacity.

D. Casing

The pump casing shall be ASTM A536 ductile cast iron, semi-concentric designed, with a 125 lb. flanged centerline discharge.

E. Impeller

Shall be semi-open type with pump out vanes to reduce seal area pressure, and to draw lubricant down from the reservoir should seal leakage occur. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a set clearance between the impeller and cutter bar of .010" to .015". Impeller shall be cast from ASTM A148 Gr. 90-60 alloy and heat treated to a minimum of Rockwell C60 Hardness and dynamically balanced. The impeller shall be keyed to the shaft and shall have no axial adjustments or set screws required. Impeller shall not extend beyond the cutter bar for any reason.

F. Cutter Bar

Shall be recessed into the pump bowl, with a funnel shaped inlet openings, and shall extend diametrically across entire pump suction opening. Cutter bar shall be cast from ASTM A148 Gr. 90-60 cast alloy steel and heat treated to a minimum of Rockwell C60 Hardness.

G. Cutter Nut

The impeller shall be secured to the shaft using a special cutter nut, designed to cut stringy materials and prevent binding. The cutter nut shall be cast from ASTM A148 Gr. 90-60 cast alloy steel and heat treated to a minimum of Rockwell C60 Hardness.

H. Upper Cutter

Pump configuration shall include an upper cutter to cut and expel stringy materials and prevent fouling of the pump.

1. Upper cutter shall be threaded into the back pullout adapter plate above the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. Upper cutter shall be cast steel heat treated to minimum Rockwell C 60.
2. Alternatively, the area behind the impeller shall be protected from fouling by the cutting and expulsion action of serrated and sharpened teeth in the rear impeller shroud sweeping across spiral grooves in the backplate.

I. Pump Shafting

The pump and motor shafts shall be direct-coupled or one-piece. Pump shafting shall be high-strength, heat-treated steel. The pump stub shaft and impeller shall be supported by lubricated, ball or roller anti-friction bearings.

J. [Not Used]

K. [Not Used]

L. Spark-Proof Guide Rail System

Provide a non-sparking guide rail system consisting of two stainless steel guide rails, cast aluminum-bronze pump guide bracket, ductile iron discharge elbow with mounting feet and 125 lb. flange, upper guide rail mounting bracket, and intermediate guide brackets every 10 feet.

M. Recirculation Nozzle Assembly

The scum pumps shall be fitted with a recirculation nozzle assembly to permit recirculation of the pit contents prior to discharge. The recirculation nozzle shall be adjustable 180 degrees horizontally and 45 degrees vertically. A valve assembly shall be connected to the pump discharge to adjust pump flow either to the nozzle or the pump discharge flange. Valve shall be ASTM A536 ductile cast iron, with 316 SS valve disk. The valve operating levers shall be located 20" minimum above at a

mounting plate for easy access and shall be provided with connections to the linear actuator.

N. [Not Used]

O. Upper Mounting Plate

The upper mounting plate shall be located as shown on the Contract Drawings and a minimum of 20" above the sump pit top of slab elevation.

P. Valve Operator Linear Actuator

1. The valve operator levers shall be coupled to an electric actuator which shall automatically position the recirculation valve for pumpout, agitation, or mixed operation service. The linear actuator shall be a ball screw linear type actuator.
2. The actuator shall operate on 120 VAC, single-phase power supply. Ampere draw shall not exceed 1.7 Amps. The actuator shall be provided with overload and short circuit/ground fault protection as required per the National Electric Code.
3. The actuator shall be capable of producing 500 lbs of actuation force, with a freewheeling feature to prevent overtravel at the end of stroke. External 0-30 second timers shall control the length of time the linear actuator motor runs, which in turn shall determine valve position. A solenoid brake shall be integral with the actuator to hold valve position, and a capacitor for single phase motor starting shall be included in the design of the electric actuator controls.
4. Controls shall be provided in the Pump Control Panel specified herein.

2.5 SCUM PUMP CONTROL PANEL & ACCESSORIES

A. General

1. Provide one Scum Pump Control Panel with level controls to operate the scum pump.
2. The pump control panel shall be furnished as a coordinated assembly requiring only field connection of the level control devices, 480 VAC power supply, and Process Control System input/output signals.
3. Classification: All electrical work within, entering or leaving the process tanks shall be explosion proof or intrinsically safe. Intrinsically safe circuits shall utilize intrinsically safe barriers, relays, and wiring as required for Class I, Group D, Division 1 Hazardous Location installations.
4. Control panel components shall be provided in accordance with applicable portions of Division 16 Sections "Electrical Control Components" and "Packaged System Control Panels" and shall interface with the Process Control System as shown on the Piping and Instrumentation Diagrams.

B. Scum Pump Control Panel

1. Pump control panel shall be UL listed and labeled under UL 508A.
2. Controls shall be provided as required to perform pump-down control functions as specified. Control panel shall include main disconnect circuit breaker with external operating handle, motor starters, control power transformers, control relays, timing relays, intrinsically safe relays, moisture and temperature sensing control relays, and miscellaneous controls as required by the pump manufacturer. Special controls specifically required for operation with the pump such as the moisture and temperature sensing relays shall be provided by the pump manufacturer.
3. Operator controls shall be located on the face of the control panel.
4. Circuit breakers shall be provided for disconnecting power to the control panel. External operating handle shall include provisions for locking in the open position.
5. Pump control panel enclosure shall be stainless steel, rated NEMA 4X. Panel shall be sized to accommodate wiring and controls as specified. Components shall conform to the requirements of UL 508.

C. Controls and Instrumentation

1. Float switches and pressure transducers shall be as specified in applicable Division 17 Sections.
3. Control relays and pilot devices shall be as specified in the Section entitled "Electrical Control Components".
4. Internal wiring and terminal blocks shall be as specified in the Section entitled "Packaged System Control Panels".

D. Nameplates shall be provided as scheduled on the Contract Drawings.

2.6 SOURCE QUALITY CONTROL

- A. Submersible recirculator chopper pumps shall be assembled, wired completely, and given running tests at manufacturer's plant before shipment. Tests shall be in accordance with the Section entitled "Tests on Pumping Equipment".

2.7 SPARE PARTS

Spare parts for the submersible chopper pumps shall be provided in the quantities listed below.

- A. One each of the following for each model pump:

1. Gaskets
2. O-ring seals
3. Shaft bearings and seals

4. Keys
5. Shaft coupling
6. Cutter bar
7. Impeller
8. Pump mechanical seal

2.8 SHOP PAINTING

- A. Surface preparation and application of the standard primer and finish paint coats for the pumps shall be provided by the manufacturer.

2.9 LEVEL CONTROL AND LEVEL MONITORING

- A. Float switches and pressure transducers shall be provided for level control and level monitoring as shown on the Contract Drawings and as specified.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The submersible pumps and accessories shall be installed by the Contractor in accordance with the Contract Documents, the configuration shown on the Contract Drawings, and manufacturer's instructions and recommendations. The Contractor shall make all necessary adjustments to equipment to provide a complete operational installation of the submersible pumps upon completion of the project.
- B. The manufacturer shall provide a complete detailed operating and maintenance manual for each model pump in accordance with the General Provisions. This manual shall cover, in addition to general operating procedures, the operation, maintenance and service procedures of the major individual components provided with the pumps.

3.2 FIELD TESTING

- A. Field testing of each of pumping equipment specified herein shall be performed in accordance with the Contract Documents as follows:
 1. Pre-test Checkout
 - a. The Contractor shall demonstrate that each unit:
 - (1) Has not been damaged by transportation or installation.
 - b. For each unit, the Contractor shall perform the following:
 - (1) Check for piping stresses after final alignment and bolting. Loosen flange bolts and measure pipe deflection or movement due to forcing pipe into position. If movement occurs, realign piping.
 - c. Pump Prestart Checks

- (1) Rotate each pump by hand to determine free rotation with motor leads disconnected.
 - (2) Briefly start each pump motor to determine if pump rotates in the correct direction.
 - (3) Demonstrate that all devices intended to start, stop and protect each pump will operate properly.
 - d. Adjust, test and calibrate as required, all controls, switches, drive unit(s) and other instrumentation and control equipment associated with the equipment specified in this Section.
 - e. The Manufacturer or System supplier shall have inspected the system, and submitted Certificate of Installation, either prior to or concurrent with the pre-test checkout.
2. Performance Test
- a. Perform pump running tests in accordance with the Section, entitled "Tests on Pumping Equipment".
 - b. In addition, demonstrate the following for each pump:
 - (1) Verify pump can be hoisted out of the wet well and rotated to the side using a "Multi-Purpose Hoist" provided per the Section entitled "Hoisting Equipment". Inspect the pump before lowering back into the wet well or grease tank.
 - (2) During all testing, verify that the pump is free from overload and overheating.

3.3 MANUFACTURER'S FIELD SERVICE

- A. Provide manufacturer's services at the jobsite designated by the Owner for the minimum hours listed below, travel time excluded:
1. 8 hours for installation assistance, inspection, and certification of installation.
 2. 8 hours for performance testing.
 3. 8 hours for operational training.
- Each jobsite visit shall be scheduled separately with minimum seven (7) calendar days notice prior to each visit. The service visit for operational training shall be scheduled in coordination with the Owner's operations staff and shall be at such times as requested by the Owner.
- B. Above services shall be provided by the manufacturer's qualified factory-trained service staff.

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SECTION 44 31 21

ODOR CONTROL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 40 05 13.76 – FRP Ductwork
- C. Section 13 42 13 – Fiberglass Reinforced Polyester (FRP) Modular Type Building
- D. Division 26 - Electrical

1.2 SUMMARY

- A. This section covers the odor control system to be provided and installed as specified herein and as indicated on the contract drawings. The headworks odor control system shall include a bioscrubbing filter system utilizing biologically active synthetic media with an automated water and nutrient injection spray system, interconnecting piping and valves, control panel, exhaust fans, and accessories necessary for a complete system. The headworks odor control system shall include a fiberglass reinforced plastic prefabricated building to house any equipment susceptible to freeze conditions with exception to the tower and blowers as shown on drawings.

1.3 QUALITY ASSURANCE

- A. Equipment and materials provided under this Section shall be the standard product in regular production by manufacturers who shall have at least five years experience in the design and fabrication of the equipment as described herein, used for similar applications and shall have at least five installations in satisfactory operation.

1.4 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:
 - 1. Biotrickling Filter

1.5 SUBMITTALS

- A. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:
 - 1. All structural design calculations shall be prepared by the manufacturer and sealed by a registered professional engineer.

2. Manufacturer's literature, illustrations, specifications, and engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.
 3. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
 4. Electrical wiring diagrams clearly indicating the required field-wiring connections.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor non-conformities, and detailed explanation of other non-conformities.
- C. Submit Operations and Maintenance Manuals in accordance with the General and Supplementary Conditions.
- D. Submit Manufacturer's Certificate in accordance with the General and Supplementary Conditions.

1.6 SYSTEM DESCRIPTION

- A. The headworks odor control system shall be designed to operate under the following conditions:
1. Process application Headworks / Screen & Grit /Fine Screen
 2. Ambient operating temperatures -10 to 100 °F
 3. Elevation 930 ft
 4. Design airflow rate 2,000 - 5,000 ft³/min
 5. Inlet air temperature 40 to 100°F
 6. Inlet H₂S concentration
 - a. Maximum 500 ppm
 - b. Average 250 ppm
 7. Inlet Methyl Mercaptans Concentration
 - a. Maximum 12 ppm
 - b. Average 2 ppm
 8. Minimum H₂S removal efficiency 99%
Minimum Methyl Mercaptan removal efficiency 99%

9. Maximum pressure drop @
design flow rate 7.8" w.c.

1.7 STORAGE AND PROTECTION

- A. Store and protect the odor control systems and accessories in accordance with the requirements of Section 01.

1.8 GUARANTEE

- A. Provide a guarantee against defective equipment and workman ship in accordance with the requirement of Section 01.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. The odor control systems specified herein and shown in the Contract Documents are based on systems as manufactured by Evoqua Water Technologies, Inc. (San Diego, CA).

2.2 FAN AND MOTOR ASSEMBLY

A. HEADWORKS FAN

1. The fan shall be a centrifugal industrial FRP fan that is AMCA certified and licensed to bear the AMCA seal.
2. All parts of the fan that are exposed to the airstream shall be encapsulated in FRP to insure corrosion resistance.
3. The fan shall be equipped with the following features and accessories:
 - a. Flanged outlet / slip-on inlet
 - b. Drain
 - c. Shaft seals, Viton
 - d. Inspection port
 - e. Safety belt guard
 - f. Lifting eyes
 - g. Epoxy-coated heavy-gauge all-welded steel base
 - h. Variable frequency drive
4. Fan shall be as manufactured by Hartzell Air Movement or equal.

B. MOTOR

1. The motor shall be rated at 15 HP and shall be 3-phase, 60 Hz, 230/460 Volt. The fan should be rated for 5,000 CFM @ 3.5" WC (not including the losses across the odor control equipment) and be able to be adjusted between 2,000 and 5,000 CFM via a variable frequency drive.
2. Motors should meet explosion-proof rating following Class I, Division II, Group D requirements, minimum.
3. The motor shall have a TEFC enclosure.

C. SYSTEM FANS CONTROL PANEL - Non-Hazardous Location:

1. A NEMA Type 4X FRP Combination Motor Starters shall be provided to operate the system fans.
2. The panel shall include fusible disconnect switches, control transformers, motor starters equipped with a solid-state overload relay assembly, start and stop pushbuttons, and red "ON" transformer type pilot lights.
3. Pushbuttons and pilot lights shall be door and/or flange mounted and be NEMA Type 4X.

D. FINE SCREEN BUILDING INLINE FAN

1. An inline, explosion-proof fan shall be provided in the 8-inch fine screen effluent ductwork as shown on drawings rated for 400 CFM at 1 HP.
2. The motor shall be single speed, 3-phase, 60Hz, 230/460 Volt. The manufacturer shall supply all necessary controls.
3. The fan shall be adequate for outdoor use including freezing conditions.

2.3 Biotrickling Filter Vessel:

- A. The reactor vessel shall be free standing, packaged or skid mounted. Vessel shall be constructed from fiberglass reinforced plastic (FRP) in accordance with ASTM D4097 and C582, treated to withstand UV light. Vessel shall be completely corrosion resistant.
 1. All gaskets shall be EPDM.
- B. Accessories: Air inlet, air outlet, spray headers, baffles, media support, drain and all connections shown on the Contract Drawings shall be provided by the manufacturer.
- C. Each tank shall be furnished with concrete anchors and hold down lugs, complete with 316 stainless steel plates, bolts, nuts, and washers for proper anchoring of the tank as required by the design calculations.

- D. Neoprene Pad: A 1/4-inch thick, 60 durometer neoprene rubber sheet must be placed underneath each vessel. Provided by others
- E. Each bioscrubber sump shall be equipped with a titanium or hastelloy grounding rod. The grounding rod will provide an earth ground for the bioscrubber solution. The Contractor shall install a grounding rod adjacent to the bioscrubber for connection to the lugs.
- F. Unless otherwise specified, all fasteners, and metal attachments, such as anchors, brackets etc shall be ANSI 316SS.
- G. Biotrickling Filter Media
 - 1. The synthetic structured media shall be high porosity, chemically resistant, engineered synthetic porous material. Organic, carbon derived media, and/or non-synthetic inorganic media materials will not be allowed.
 - 2. The biological media characteristics (available surface area, density, and pressure drop) shall be structured and uniform throughout the media bed.
 - 3. The synthetic, biological media shall have a minimum available specific surface area of 230ft²/ft³ and a void opening of at least 96%.
 - 4. Media shall resist compaction or swelling due to varying moisture levels and shall not degrade when subjected to low pH (i.e. pH<2) conditions.
 - 5. The uniform structure of the media shall minimize the potential for short circuiting and encourage a uniform water and air flow pattern over the entire media cross sectional area. The media configuration shall promote thorough mixing and good contact between the gas and irrigation solution.
 - 6. Only unapproved equals shall provide evidence that the airflow through the biological media is homogeneous at the average airflow rate. For purposes of this specification, homogeneous is defined as being when the air velocity over the entire media cross sectional area is equal to the average air velocity $\pm 10\%$. The airflow modeling results with velocity contour plots over the entire cross section shall be provided.
 - 7. Sufficient media shall be provided to ensure the performance requirements of this specification are met.
 - 8. Media support plates shall be VINYL ESTER FRP GRID type. Free area shall be a minimum of 95 percent of the cross-sectional area of the tower. Packing support plates and mid span supports shall be suitable to support weight of the packing specified plus entrained recirculation solution. Opening size shall not allow passage of packing media in any random orientation. Construction shall be fiberglass constructed of vinyl ester resins. Furnish Manufacturer instructions for placement and removal of the packing support in and out of the tower.

H. Irrigation System

1. Each liquid distribution header shall be provided to uniformly distribute the scrubbing liquid onto the packing material. Internal spray piping shall have flanged connection for easy removal without entering the vessel. Each liquid spray distributor system shall be PVC or FRP. A non-clog spray nozzle shall be attached to each header. Pressure loss across the nozzle(s) at design capacity shall be no more than 10 psi. The spray nozzle(s) shall be Teflon, polypropylene, or PVC.
2. Each irrigation system shall be tested by the Manufacturer and a certificate of conformity supplied with the shop drawings to show that the nozzle has been tested and meets the Manufacturer's standards for uniform distribution.
3. The irrigation system shall be supplied with a nutrient addition system to provide the nutrients required by the bacteria for optimal metabolism of the odorous compounds being treated.

I. All piping and accessories for the drain/overflow assembly, RAS injection port, differential pressure gauge, and sample ports shall be Sch. 80 PVC or polypropylene and provided by the biotrickling filter Manufacturer. All external piping shall be insulated and heat traced by the Contractor if required by the climate conditions.

J. Biological Sump Heater

1. An immersion heater in the sump shall be installed with an integral thermostat controller. It shall be of screw plug immersion type, manufactured of 304 stainless steel, with Hastelloy C-276 heating element. The immersion length shall be a minimum of 10". The heating units shall be made of material resistant to corrosion by the chemicals present. The heating elements shall be provided with a watt density 19 W/in². Each immersion heater shall have a 2" MNPT fitting.
2. The unit shall be powered from the control panel, 3 phase, 460 VAC and rated for 1.5 kW. The controls shall be housed in a NEMA 4X rated enclosure. The wiring shall be factory assembled and tested prior to shipment.
3. The manufacturer shall be Watlow or approved equal.

K. Control System

1. Electrical Control Panel (ECP)
 - a. The ECP enclosure shall be NEMA 4X and constructed of FRP.
 - b. The ECP shall house the necessary electronic components and operate using a relay based control system. No PLC shall be necessary. The system shall be controlled on the basis of time for the irrigation cycle and irrigation time shall be adjustable to sustain conditions appropriate to the

activity of the bacteria. There shall be an allowance to manually operate the irrigation spray for the purpose of routine maintenance checks.

- c. The electrical control panel shall include a pH analyzer to monitor recirculation solution. The pH controller shall have a digital pH display, with a menu driven operation for easy calibration and setpoint adjustment. The controller shall have a 4-20 mA output .The controller shall be Hach sc200 or equal. The control panel shall provide the following signals for remote monitoring (dry contacts):

- 1. pH value of recirculating solution/low pH alarm
- 2. Recirculation pump low flow alarm or flow value

- d. The ECP shall require a single electrical connection as shown on the Electrical Drawings or as required.
- e. All electronic components shall be rated for Class 1, Division 2 environments.

2. Water Control Panel (WCP)

- a. The Water Control Panel shall be constructed of FRP, and be integral to the bioreactor vessel and be of the same material as vessel.
- b. The WCP shall contain a panel heater if required, valves, solenoid valves, strainers, metering pumps, pressure gauges, flow meters, instruments and piping, as needed, for the control of the irrigation system and shall operate from control signals from the ECP.
- c. The WCP shall allow for a single connection to a potable water source and a single connection to a recirculation pump.
- d. The WCP shall house the nutrient addition system.

L. Exhaust Dispersion

- 1. Biotrickling Filter Vessel shall be provided with an outlet exhaust dispersion system to minimize visual effect of exhaust plumes.

2.4 INTERCONNECTING DUCTWORK

- A. Ductwork between the reactor vessel and the exhaust fan shall be provided by Contractor.
- B. Ductwork assembly and design shall be compatible with the fan and vessel.
- C. An expansion joints shall be included in the ductwork and installed at the outlet of the exhaust fan. The expansion joint shall dampen axial, lateral, and vibrational duct

movement. The expansion joint shall be resistant to ultraviolet degradation and to the corrosive gases being processed. The expansion joint shall be of a flanged design.

2.5 MIST ELIMINATOR

- A. Mist Eliminator unit shall consists of a 304 SS pad for grease filtration in front of a polypropylene mesh pad with 304SS grids for mist elimination, housed inside an FRP enclosure. The pads shall be removable for cleaning and the housing shall have a drop-out flange to allow removal and replacement of the filter pads. The mist eliminator pads shall be style 7CA/8P by ACS Industries. The FRP housing shall be flanged and drilled per PS 15-69, and be ready for installation into the system supply ductwork. A Dwyer Series 2000 Magnehilic gage station shall be installed on the housing to indicate pressure drop through the unit.

2.6 ACCESSORIES

A. FLOW CONTROL DAMPER

- 1. A round FRP butterfly damper shall be supplied to regulate airflow through the reactor vessel. The damper shall ship loose and be ready for installation into the reactor system supply ductwork The damper shall be furnished by the contractor.

B. FRP ENCLOSURE

- 1. The water control panel and process appurtenances shall be located in an insulated FRP enclosure provided by the manufacturer. All equipment to be located in the enclosure shall be installed by the manufacturer to the greatest extent possible prior to delivery including the control panel, water box, nutrient tank, water pumps, lighting, and HVAC.
- 2. The enclosure shall be designed by the manufacturer to provide a 3 feet minimum clearance around all equipment and panels.

PART 3- EXECUTION

3.1 FACTORY ACCEPTANCE TEST

A. FRP Vessels

- 1. FRP vessels shall be inspected prior to shipping for conformance to the following:
 - a. Dimensions match those shown on submittal drawings and are within Manufacturer's specified tolerances.
 - b. Flanges and connections between reactor parts fit securely without improper bending or stressing of parts.

- c. Damage or imperfections, including cracking/crazing are minimal and in accordance with this specification.
- d. Manufacturer shall keep a record of the quality control document for each reactor vessel that is available to the Engineer upon request.

B. Electrical Control Panel:

- 1. Electrical control panel shall be inspected prior to shipping for conformance to the following:
 - a. NEMA rating according to this specification
 - b. All wiring between panel components and terminal strips shall be checked for proper labeling and connection.

C. Water Panel

- 1. All water panel piping and/or other pre-installed piping shall be tested prior to shipping for conformance to the following:
 - a. System shall have no leaks when subjected to a pressure test at 80 psi for a minimum of 1 hour.
 - b. All installed instruments, sensors, pumps, actuated valves, and other electrical components shall be tested for proper operation.
 - c. All wiring from terminal strips to all electrical components shall be tested to ensure proper wiring.

D. Spray Nozzles

- 1. Irrigation system shall be factory tested to ensure compliance with Manufacturer standards for uniform distribution.

3.2 INSTALLATION & EQUIPMENT STARTUP

- A. To the extent possible, all equipment shall be pre-assembled prior to shipment to minimize the need for on-site assembly. Synthetic biological media should be pre-installed by the Manufacturer and certified to meet the specified performance requirements.
- B. Installation of all equipment shall be in accordance with Manufacturer's written installation and startup instructions and by workers experienced in the handling of FRP vessels, electrical work, plumbing and instrumentation. The final installation must be certified by the Manufacturer as complete and correct.

- C. The Manufacturer shall provide the Contractor with required clearances, tolerances and limitations, such as smoothness/flatness of concrete pad and shall be available to answer questions prior to and during the installation of the equipment.
- D. Contractor shall install water supply with pressure regulator, gravity drain to wetwell with a barometric P-trap, electrical service for all required equipment which may include, but is not limited to, blower, recycle pump, metering pump, valves and controls, and all other accessories and appurtenances as may be required by the Manufacturer for a complete and operational system.
- E. Contractor shall install heat trace and weatherproof insulation on all piping to prevent freezing if applicable.
- F. Once the installation has been certified by the Manufacturer, the Contractor, with supervision from the Manufacturer, shall start the System to begin the biological acclimation period. This startup period shall take no longer than six (6) weeks but at any point during this startup period, at the discretion and direction of the Manufacturer, the Contractor shall switch the system over to normal operation. Any minor re-piping or plumbing required will be clearly detailed in the Manufacturer's installation and startup manual and will be performed by the Contractor.
- G. Manufacturer's factory trained engineer must inspect the system 4-6 weeks after start-up. If the process is not running within the specified parameters, repairs shall be made and another inspection shall be performed after another 4-6 weeks. This process will be repeated as necessary.
- H. Any special tools or materials required for this startup/acclimation period shall be provided by the Manufacturer.
- I. After satisfactory startup and the corresponding switch over to normal operation, the Contractor shall, in the presence of the Owner, conduct the performance test as detailed below.

3.3 FIELD PAINTING & CORROSION PROTECTION

- A. If painted surfaces are damaged during shipment, off-loading or installation, as long as the damage is surface only and in no way affects the integrity of the equipment or its ability to perform, these blemishes, scratches or other imperfections shall be touched up by the Contractor in accordance with instructions from the Manufacturer. Materials used shall be compatible with the original coating material in quality and color.

3.4 PERFORMANCE TESTING

- A. Performance testing shall not commence until the Manufacturer and Owner agree that the system has been satisfactorily started-up and sufficient time has been allowed for the acclimation of the bacteria.

- B. After the odor control system has been satisfactorily started-up and switched to normal operation, the Contractor shall, in the presence of the Owner, demonstrate that the system will perform as specified.
- C. The Contractor shall provide the Engineer with a written test protocol and the performance testing may not be conducted until the test protocol has been reviewed and approved by the Engineer.
- D. The Contractor shall supply, install and operate all equipment, sensors and instrumentation required to complete the performance testing.
- E. H2S Testing Procedure
 - 1. Measure airflow into each unit and adjust to the design airflow +/-10% if necessary. Airflow shall be measured at the beginning of the test period. The set position on the damper shall be marked or noted. Airflow shall not change as long as damper remains in position.
 - 2. Measure pressure drop across each biotrickling filter at beginning of test period.
 - 3. Measure temperature and relative humidity of the inlet, outlet and ambient air.
 - 4. Performance test period shall begin at a noted time and last for four (4) hours. H2S data from the common inlet location and from the outlet of each odor control system shall be measured and logged once every 10 minutes to demonstrate performance during the test period.
 - a. The inlet H2S data shall be logged with a pre-calibrated OdaLog gas data logger with appropriate range and accuracy for the inlet air stream (0-1000 ppmv or 0-200 ppmv range, 1 ppm display resolution or 0.0-50.0 ppmv range, 0.1 ppmv display resolution).
 - b. The outlet H2S data shall be logged with a pre-calibrated OdaLog gas data logger with appropriate range and accuracy for the outlet air stream (0.00-2.00 ppmv range, 0.01 ppmv display resolution or 0.0-50.0 ppmv range, 0.1 ppmv display resolution).
- F. H2S Acceptance Criteria
 - 1. The system's H2S removal efficiency shall be determined by calculating the average inlet H2S concentration and the average outlet H2S concentration and using the following formula: $\text{H2S removal efficiency (\%)} = (1 - \text{average inlet H2S concentration} / \text{average outlet H2S concentration}) \times 100$. Data points that are greater than 2x the average will not be included in the calculation. The H2S removal efficiency must meet the criteria specified above for the system to be accepted.

3.5 MANUFACTURER'S SERVICES

- A. In addition to being available by phone to assist the Contractor during the off-loading, installation, and startup of the equipment, the following Manufacturer's services shall be provided with the number of trips and days on site as a minimum:
- B. Startup assistance: Manufacturer's factory trained engineer for Two (2) separate trips, Three (3) days each. Performance testing assistance and personnel training will take place during this time as well.
- C. Notwithstanding the above, the Manufacturer shall continue to assist the Contractor with questions, issues and remote assistance until the system is properly installed, running satisfactorily and handed over to the Owner.

3.6 EQUIPMENT NAME PLATES

- A. Each separate piece of equipment shall be furnished with a unique name plate identifying the Manufacturer, model & serial number, date of manufacture and, if applicable, capacity and any performance limitations. The nameplates shall be engraved stainless steel and firmly affixed to the exterior surface of the equipment and in a location that is accessible and easily read.

* * * * *

SECTION 46 21 43

BAND SCREENS AND SCREENING WASHING MACHINES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 26 Electrical
- C. Motors shall conform to requirements of Division 26 Section “Common Motor Requirements.”
- D. Control Panels shall conform to requirements of Division 26 Section “Packaged System Control Panels.”

1.2 SUMMARY

- A. Supply all labor, materials, equipment and incidentals required to install and place into operation the fine screening system as shown on the Drawings and as specified herein.

1.3 QUALITY ASSURANCE

A. GENERAL

- 1. The Contractor shall be responsible for ensuring that all equipment installed is properly connected to other related equipment for proper functioning of the plant.

B. WARRANTY

- 1. The Contractor shall provide from the equipment Manufacturer an extended warranty for a period of 12 months after acceptance of equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event that the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

C. MANUFACTURER’S QUALIFICATIONS

- 1. Equipment and materials provided under this Section shall be the standard product in regular production by Manufacturers who shall have at least five years experience in the design and fabrication of the equipment as described herein, used for similar applications and shall have at least five installations in satisfactory operation.

1.4 EQUIPMENT IDENTIFICATION

A. Equipment covered under this specification is identified as follows:

1. Fine Screen No. 1
2. Fine Screen No. 2
3. Washing Compactor No. 1
4. Washing Compactor No. 2

1.5 REFERENCE STANDARDS

A. The properties of all materials, design, fabrication and performance of the equipment to be furnished under this section shall be in accordance with the latest issue of applicable standard specifications. The governing authorities of these standards are listed below.

1. American Institute of Steel Construction (AISC)
2. American Iron and Steel Institute (AISI)
3. American National Standards Institute (ANSI)
4. American Society of Civil Engineers (ASCE)
5. American Society of Mechanical Engineers (ASME)
6. American Society of Testing and Materials (ASTM)
7. American Welding Society (AWS)
8. International Building Code (IBC)
9. International Electric Code (IEC)
10. Institute of Electrical and Electronics Engineers (IEEE)
11. National Electrical Code (NEC)
12. National Electrical Manufacturers Association (NEMA)
13. Underwriters Laboratory (UL and cUL)

1.6 SUBMITTALS

A. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:

1. All structural design calculations shall be prepared by the manufacturer and sealed by a registered professional engineer.

2. Manufacturer's literature, illustrations, specifications, and engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.
 3. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
 4. Electrical wiring diagrams clearly indicating all of the required field-wiring connections..
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor non-conformities, and detailed explanation of other non-conformities.
- C. Submit Operations and Maintenance Manuals in accordance with the General and Supplementary Conditions.
- D. Submit Manufacturer's Certificate in accordance with the General and Supplementary Conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The design has been based on based on equipment provided by the following Manufacturers:
1. HydroDyne Engineering, Inc..
 2. JWC Environmental, Inc.
 3. Bracket Green (Ovivo)
 4. Or equal
- B. If submitted equipment requires arrangement differing from that specified, or shown on the Drawings prepare and submit for review complete structural, mechanical, and electrical drawings and equipment lists showing all necessary changes and embodying all special features of equipment proposed. Any changes are at no additional compensation and the Manufacturer will be responsible for all engineering costs of redesign by the Engineer, if necessary.

2.2 FINE SCREEN

A. SYSTEM PERFORMANCE

1. The Fine Screens shall be capable of the following performance requirements:

1.	Number of Screens	2
2.	Peak Flow Rate Per Filter	27.0 MGD (18,750 gpm)
3.	Average Flow Rate Per Filter (Design ADF = 17 MGD)	18.5 MGD (12,847 gpm)
4.	Maximum Screen Grid Opening	5.0 mm
5.	Channel Width	36 inches
6.	Channel Depth	84 inches
7.	Maximum Head Loss at Peak Flow	12 inches at 50% Blinding
8.	Wash Water Requirements, Each	52 gpm @ 60 psi (minimum)

B. GENERAL

1. The fine screen will have a continuous stainless steel belt that automatically rotates within the internal guide system of the static frame.
2. The fine screen herein specified will be of the center-flow type. The flow enters the inside of the continuous belt and exits through both sides and the bottom of the belt.
3. The screen shall have undergone performance testing by an industry recognized, independent testing facility. The results of this testing shall verify a Screening Capture Ratio of at least 84% for solids equal to or larger than the screen grid opening listed in System Performance below.
4. The screen will be installed into the channel as shown on the Contract Drawings to accommodate the flow pattern through the screen belt.
5. The solids will collect as a mat on the inside of the continuous belt. The belt will intermittently rotate and elevate the solids to the discharge point. Larger objects will be picked up by a series of hooks and trays placed at regular intervals.
6. The solids will be removed at the top of the screen by two spray bar headers positioned on the outside of the belt. The screenings will drop into an internal hopper and be fed to the screening handling system.
7. The continuous belt will be directly driven by drive sprockets that shall support and rotate the grid assembly.
8. The screen will be totally enclosed and have access covers that will be lightweight and easily removable for maintenance.
9. The screen enclosure shall be provided with a 6" pipe flange connection for connection to FRP odor control piping by others.

C. PERFORATED PLATE - CONTINUOUS SCREENINGS BELT

1. The screenings belt will consist of panels manufactured from 3/8" thick UHMWPE with perforations of the specified opening.
2. The perforated panels will be supported by 12 gauge stainless steel vertical mounted lifting hooks horizontally spaced a maximum of 3 inches apart preventing deflection. The lifting hooks shall support the screening grid and bear tension loads across the entire length and width of the screen belt.
3. The hooks on elements shall form horizontal lifting trays or shelves for removing large solids and rags every 8 inches around the entire screen grid.
4. The perforated panels will be connected by heavy duty stainless steel axles every 8 inches to form a continuous belt that will rotate within the frame's guide system. The axle design will allow the plates to pivot and create a seal between the perforated panels to prevent the passage of solids.
5. The axles will include Delrin spacers that will maintain the 3 inch space between the vertical support elements. Delrin spacers will also form a seal between each perforated panel with clearance not to exceed 0.5mm.
6. The axles will be extended to fix a UHMWPE guide link to the side of each perforated plate. These guides will interlock to create a continuous guide link system that will slide within the frame.
7. The heavy duty guide links will be minimum 2 inches thick to protect against undue wear from grit and will be specially machined to form a closure seal between the rotating belt and the static frame.
8. The seal shall be continuous from grade level through the water flow forming an uninterrupted closure between the traveling screen grid and the stationary frame. The seal shall be heavy gauge stainless steel, fixed to the screen frame and be adjustable so it will remain in contact with the rotating screen belt at all times. There shall be no gap in the grid to frame seal larger than 0.5mm.
9. Guide systems that use rollers, stainless or hardened steel chains will not be acceptable.
10. Grid panel sealing systems that use neoprene seals or stainless steel hinges will not be acceptable.
11. Grid to frame sealing systems that use adjustable UHMWPE strips attached to the frame will not be acceptable.

D. FRAME

1. The continuous belt will rotate within a heavy duty stainless steel static support frame that shall be a rectangular box construction.

2. The guide link system will travel around a stainless steel guide wear track that is integral to the support frame. Top and bottom wear tracks shall be bolt in and field replaceable.
3. There shall be a removable inspection panel located directly beneath the drive allowing easy access to the grid drive sprockets, drive shaft and screenings collection hopper.
4. The design will ensure that the support frame meshes with the closure seal on each guide link to prevent passage of screening material and grit particles.
5. The frame shall accommodate stainless steel protective covers designed to prevent leakage and contain spray wash. All access covers for maintenance will be lightweight and easily removable. Screens with covers requiring neoprene, rubber or plastic seals are not acceptable.
6. The screen manufacturer will supply the stainless steel angled filler plates to connect from the upstream corners of the support frame to the channel walls.
7. The back-plate of the screen shall be furnished with a bypass gate that will allow manual removal for complete flow bypass.

E. OFFLOADING OF SCREENINGS

1. Two stainless steel spray wash headers will be located in the head space of the screen to offload the screenings from the continuous belt.
2. The spray bars will incorporate brass nozzles at 2 inch spacing that can easily be replaced or removed for cleaning.
3. The spray bars will be positioned behind the rotating belt and will backwash the solids into an internal hopper manufactured from stainless steel. The wash water will be used to continuously flush the screenings from the internal hopper directly into the Washing Compactor.
4. The addition of a rotating or static brush system to aid offloading will not be acceptable.

F. DRIVE MECHANISM

1. Each screen will have a single 1/2 hp, electric motor suitable for a 460/3/60 supply and rated for a Class 1 Div. 1 explosion proof environment. The motor will be TEFC NEMA rated. The motor will be located outside of the screen covers and above the top of the channel.
2. The gear reducer shall be directly coupled to a heavy duty shaft machined from solid stainless steel round bar.
3. The drive shaft shall be supported on both ends by grease filled roller bearings. Separate grease-filled self-contained cartridge seals shall be mounted on drive

shaft between bearings and frame to eliminate spray wash from entering bearings or gear reducer.

4. The continuous belt will be supported and rotated around heavy duty stainless steel sprockets located on the drive shaft in the head space of the screen.
5. These sprockets will have lugs that transmit torque directly from the gear reducer to notches on the underside of the UHMWPE guide links. Driving forces shall be transmitted to areas located behind the screen's grid to prevent solids from contacting drive surfaces.
6. Chain-driven systems or screens with wheels submerged in the wastewater are not acceptable.

2.3 WASHING COMPACTOR

A. DESIGN CRITERIA

1. The Washing Compactors were designed based on the following criteria:

1.	Number of Washing Compactors	2
2.	Screw Diameter	8 Inch
3.	Shaft Diameter	2.375 Inches
4.	Compactor Discharge Height Above Grade	60 Inches
5.	Wash Water Requirements, Each	4 gpm @ 60 psi (minimum)

B. GENERAL

1. The Washing Compactor will be integral to the head space of the screen.
2. The Washing Compactor will be adequately sized to handle all of the screenings and wash water that will be generated by the screen at peak flow. The system will be required to wash the screenings to reduce the organic content and compact the remaining solids into a dry plug.
3. The Washing Compactor will generally comprise of a screw auger rotating within the washing and drainage trough, a wash water system, a compaction zone and an outlet chute arrangement.
4. A portion of the washing water will enter the washing trough with the screenings. This will be supplemented by spray nozzles that will direct water on to the screenings prior to compaction. The nozzles will be recessed into the side wall of the washing trough to protect from ragging and blockage.
5. The screw will transfer the washed screenings into the compaction zone. This will be a section of stainless steel pipe followed by the UHMWPE flight support bearing. The total length of this section will at a minimum equal two full pitches of the screw flight.

6. The compacted screenings will be pushed through the compaction zone and pass through a 45 degree elbow. The outlet chute will be tapered at 1 degree along the full length and will elevate the dewatered screenings to discharge by gravity into an automatic bagging attachment, which will enclose the screenings and minimize odors.
7. The tapered outlet chute will terminate in a flange that will connect directly to a stainless steel discharge long radius elbow that will direct the compacted screenings downward into the cassette bagger. The elbow will be designed to prevent bridging of solids and will be flanged for accessibility.
8. The outlet of the discharge elbow will be a stainless steel mounting assembly that will allow a 24" diameter circular cassette of bags to slide horizontally into position.
9. The plastic cassette will house one 230 feet long continuous bag that will be released under the weight of compacted screenings dropping from the outlet chute.
10. Plastic bag shall be capable of cutting and tying off into operator determined sizes to effectively capture odor and all remaining water in screenings.
11. The bagged screenings will then fall by gravity into a waste receptacle (by others).
12. All stainless steel (including frame, grid and drive components) mentioned below as stainless steel shall be T304 stainless steel. All hardware shall be T316 stainless steel.

C. WASHING TROUGH

1. The main body will be the washing trough that will be integral to the headspace of the screen and receive screenings directly washed from the screen belt.
2. The washing trough will house the screw auger and provide a dedicated section to reduce organic content. It will comprise of angled side walls manufactured from 10 gauge stainless steel that will direct the screenings onto the screw auger, and a drainage section in which the screw auger will ride.
3. The drainage section will be a stainless steel wedge wire basket with 2 mm slots. This wedge wire drainage section shall be removable and easily replaceable in the field with no special tools. The flights of the screw will be fitted with a stiff nylon brush that will maintain contact with the wedge wire, preventing blockages. The brushes will be supplied in pre-coiled lengths with suitable clamps. The brushes must be replaceable without removing the screw from the washing trough.
4. The underside of the washing trough will be a catch pan that will collect the contaminated water that passes through the drainage section. The catch pan will feed a 6 inch diameter outlet connection. The Main Contractor will connect the pipe to take the water back to the main flow.

D. SCREW AUGER

1. The stainless steel screw auger will sit in the washing trough. Washing compactors with shaft less screws are not acceptable as a shaft is required to support the flight and provide necessary torque and compaction.
2. The auger will be a full pitch screw supported at the compaction end by minimum 5" wide UHMWPE Flight Support Bearing that creates a supporting collar around the screw flight. Each bearing ring will be designed to rotate through 180 degrees to provide a second wear surface below the screw. Each wear surface shall be fitted with a set screw that can be removed for inspection. The operator will be able to inspect and rotate the bearing by removing the outside cover without disassembling the equipment.
3. The screw will rotate allowing wash water and free organic/fecal material finer than trough openings to escape and return to the influent flow. The wash water system will flush the separated organic material through the drainage section in solution or as small particles.

E. DRIVE MECHANISM

1. Each Washing Compactor will have a single 5 hp, inverter duty electric motor suitable for a 460/3/60 supply and rated for a Class 1 Div. 1 explosion proof environment. The motor will be TEFC NEMA rated.
2. There shall be the ability to change the height of the screw within the washing trough by using adjustment bolts on the gearbox plate. This will prevent excess wear of the screw flights and trough.

2.4 CONTROL PANEL

- A. Each screen and compactor train will be provided with a Fine Screen Control Panel and local control panel that shall provide for monitoring and control of the system as shown on the P&ID's.
- B. Fine Screen Control Panel – NEMA 12 enclosure – Control panel shall include the following components for each screening system:
 1. Main lockout/disconnect switch
 2. High Differential Level Alarm Light
 3. Fused disconnect
 4. Recycle timer
 5. Hour run meter for each
 6. Control power transformer

7. Fuses and breakers
8. Screen and Washing Compactor in Auto Light
9. Motor starter
10. Motor overload sensors
11. Panel power light
12. Screen run and fault lights
13. Washing Compactor run and fault lights
14. Influent Channel High Level Alarm Light
15. Reset pushbutton
16. Variable frequency screen drive
17. Current monitors
18. Emergency Stop Pushbutton
19. Upstream Level display
20. Effluent Level display
21. Intrinsically safe isolation

C. Remote Monitoring

1. Provide dry relay contacts rated for remote process monitoring as shown on the Drawings. To include:
 - a. Screen Running
 - b. Washer / Compactor Running
 - c. System in "Auto" Mode
 - d. System Common Trouble Alarm
2. Provide for 4-20mA remote process monitoring as shown on the Drawings. To include:
 - a. Influent Level
 - b. Effluent Level

D. Ancillary Control Components -

1. Differential Level System consisting of the following per screen:
 - a. Upstream and Downstream Free Space Radar Level measurement
 - b. NEMA 4X enclosures rated for installation within a Class 1 Division 1 "Hazardous" classified area.
 - c. Loop Powered radar level sensing units producing a 4-20mA signal directly proportional to the liquid level measurement.
2. Local Control Panel – NEMA 4X and rated for installation within a Class 1 Division 1 "Hazardous" classified area.
3. Each local control panel shall consist of the following components:
 - a. Hand/Off/Auto switch for Screen
 - b. Hand/Off/Auto switch for Washer / Compactor
 - c. Emergency stop pushbutton

2.5 SURFACE PREPARATION AND PAINTING

- A. All stainless steel materials, including hardware, shall be acid passivated for quality control, removal of heat affected discoloration, surface treatment for corrosive environments and to provide a uniform finish to stainless surfaces.
- B. All ferrous surfaces (except stainless steel) shall be coated with a pre-primer, primer, and an exterior top coating, or fusion bonded polyester coating suitable for humid/wet environments for superior corrosion protection.
- C. Motor and gearbox shall be manufacturer's standard coating for humid/wet environments for superior corrosion protection.

2.6 SPARE PARTS

- A. The Manufacturer will supply the following spare parts, per screen supplied, with the equipment:
 1. Ten (10) hook links and elements spacers
 2. Two (2) grid axles
 3. Two (2) guide links
 4. Two (2) screen panels
 5. One (1) center support link

6. One (1) brush for the screw
7. Five (5) bagging cassettes

2.7 ACCESSORIES

A. The Manufacturer will supply the following accessories, with the equipment:

1. Two (2) 1" explosion proof brass body solenoid valves
2. Two (2) 1.5" wash water strainers
3. Two (2) wash water pressure gauges per screen
4. Two (2) screening bagger assemblies as detailed above

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. The screening system and all components shall be factory assembled and operationally tested prior to shipment. The equipment shall be shipped fully assembled and shall be capable of being set in place and field erected by the Contractor with minimal field assembly.
- B. During the factory test period the screening system shall be adjusted as required assuring proper operation on completion of the field installation. The Manufacturer shall supply a certification of the completion of the factory testing of the assembled screening system and appurtenances and shall certify as to the equipment being in satisfactory operating condition at time of shipment. The Engineer and/or Owner may, at their own option and expense, witness the factory test.

3.2 DELIVERY AND STORAGE

- A. The screening system shall be appropriately crated and delivered to protect against damage during shipment.
- B. An authorized representative of the Contractor shall inspect the screens on delivery to the jobsite and shall report any damage or missing components to the Manufacturer and the Engineer within 72 hours of receipt of the shipment.

3.3 INSTALLATION

- A. The installation of the equipment shall be as indicated on the drawings and in strict accordance with the Manufacturer's instructions and recommendations.

3.4 FIELD TESTS, ADJUSTMENTS AND COMMISSIONING

- A. The equipment shall be shipped completely factory assembled. Contractor shall verify all access dimensions, channel dimensions, and any interior building dimensions to ensure equipment may be installed as a factory assembled units.
- B. After completion of the installation, the equipment shall be inspected and certified by an authorized representative of the Manufacturer as being in compliance with the Manufacturer's recommendations and requirements. At such time as the Manufacturer has deemed the installation to be acceptable, the Manufacturer's authorized service representative shall make any required adjustments and shall start the equipment to assure proper operation.
- C. The Manufacturer's authorized representative shall provide instruction to the plant personnel as to the operation and maintenance of the equipment including commissioning, shut down, on-line operations, lubrication and preventative maintenance.
- D. Manufacturer shall state field service rates for a Service Engineer to Owner and Contractor. In the event that the field service time required by this section should not be sufficient to properly place the equipment into operation, and the requirement for additional time is beyond the manufacturer's responsibility, additional time shall be purchased by Contractor to correct deficiencies in installation, equipment, or material without additional cost to Owner.
- E. The Contractor shall include in his bid, the cost of the above referenced authorized service representative for a minimum of two (2) eight hour days onsite to complete the certifications and training described in this specification section.

SECTION 46 25 43

ROTATING SCUM PIPE EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for rotating scum pipe equipment and associated drives.

1.3 QUALITY ASSURANCE

- A. All equipment in this Section shall be furnished by or through a single supplier. The contractor shall be responsible for the design, coordination and proper operation of the entire system. Pumps shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer.

- B. The manufacturers shall be experienced in the design and construction of equipment for this purpose, and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than five (5) years.

C. WARRANTY

- a. The Contractor shall provide from the equipment manufacturer an extended warranty for a period of 12 months after acceptance of the equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

1.4 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:

Rotating Scum Pipe No. 1
Rotating Scum Pipe No. 2

1.5 SUBMITTALS

- A. Contractor shall submit shop drawings in accordance with General and Supplementary Conditions and Division 01.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.
- C. In addition to those submittals identified in the General and Supplementary Conditions and Division 01, the following items shall also be submitted:
 - 1. Manufacturer's literature, illustrations, specifications, and engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.
 - 2. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
 - 3. Electrical wiring diagrams clearly indicating the required field-wiring connections.
- D. Submit Operations and Maintenance Manuals in accordance with the General and Supplementary Conditions and Division 01.
- E. Submit Operations and Maintenance Manuals in accordance with the General and Supplementary Conditions and Division 01.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND SYSTEM SUPPLIERS

- A. The project Basis of Design is Jim Myers & Sons, Inc. as described in this Section.
- B. Acceptable manufacturers:
 - 1. Jim Myers & Sons, Inc.
 - 2. Amwell (A Division of McNish Corporation)
 - 3. Brentwood
 - 4. Or approved equal

2.2 SCUM PIPE

A. Pipe

1. Pipe shall be Type 304 stainless steel, and be 12" diameter with a minimum 1/4" wall thickness.
2. A 60 degree wide slotted opening shall be cut symmetrical about the vertical axis to provide a weir over which scum can flow into the pipe when rotated. Edges of the slot shall be parallel to the longitudinal axis of the pipe. Full periphery bands not less than 2" wide shall be left in the pipe at intervals not exceeding 2.0 ft to act as stiffeners.
3. The pipe shall have a vertical deflection of no more than 1/4" over the entire length of the pipe.
4. Scum pipes shall form a continuous obstruction-free path through tank walls so that scum can travel continuously across all tanks and discharge to the scum wells.

B. Bearings

1. The pipe shall be supported at each end in such a manner that a slight vertical or horizontal misalignment shall not interfere with the smooth operation of the pipe. The pipe shall be supported by and shall rotate in a Type 304 stainless steel, end bearing assembly which shall be mounted to the basin wall. The end plate shall have a 360° UHMW-PE bearing mounted on the inside of the end bearing support. The UHMW-PE bearing shall be inset within the bracket to allow for seals.
2. A suitable watertight seal shall be provided for the open end of each pipe. This seal shall be so constructed that it shall remain effective even with a slight misalignment of the pipe and end bearing support. The seal shall not be affected by grease, mild acids, or alkalis. The seal shall be readily removable without removing the pipe from the supporting brackets and shall not bind or impede the smooth action of the revolving pipe. The seal shall be held in place by an external Type 316 stainless steel adjustable retainer ring.

2.3 OPERATING MECHANISM

A. Worm Gear Operator

1. Each scum pipe shall be furnished with an electrically controlled worm gear operator capable of rotating the skimmer pipe in both directions so that either lip of the slot can be positioned at least 1" below the water level.
2. Worm gear operators shall consist of a UHMW ring gear and a nylon worm gear which shall engage to rotate the pipe as the shaft is turned. The worm gear shall

be made of cast nylon. Worms shall be 3.50 pitch diameter and 4" in length. The ring gear shall be attached to the scum pipe by 316 stainless steel bolts and shall be easily replaceable. The ring gear shall be UHWM and shall be 46 tooth with a 3" face and have a pitch diameter of 18.303.

3. The pipe supports and the worm and shaft supports shall be arranged in such a manner that a slight misalignment of the pipe will not affect the gear operation or cause a leakage.
4. The worm gear shall be supported by a bearing housing attached to the wall plate that includes UHMW bearings. No grease or oil shall be required for the operation of the ring gear and pinion operation.

B. Electric Motor Operator

1. Electric motor operators shall be by Rotork. The operators shall be provided by the scum pipe manufacturer. The operator shall include the motor, operator unit gearing, limit switch gearing, limit switches, thermal overloads and auxiliary handwheel. The electric operator shall be designed for cold temperature applications and be supplied with low temperature lubricants.
2. The scum pipe drive shall be modulating. The motor shall have torque ratings and thermal capacity specifically designed for this service and shall be 480 Volt, 3 phase, 60 Hz, totally enclosed non-ventilated construction with the motor leads brought into the limit switch compartment without having external piping or conduit box. The motor shall be capable of rotating the scum pipe against maximum torque load when voltage to the motor terminal is within plus or minus 10 percent of the nominal rated voltage. Bearings shall be the prelubricated anti-friction type. Motors shall be of weatherproof construction and shall have Class F insulation with 120 VAC space heaters for protection against moisture ingress and condensation when the motor is not running. Provide a grounding lug in the terminal connection compartment. A mechanical dial position indicator and a 4-20 mA position feedback transmitter shall be furnished for each drive.
3. The power gearing shall consist of carburized and hardened alloy steel worms with threads ground after heat treating. The worm gear shall be of alloy bronze, accurately cut with a hobbing machine. Where required, additional generated helical gears of heat treated steel shall be used. All power gearing shall be suitably lubricated with oil or grease and shall be suitable for mounting in any position. Ball and roller bearings shall be used throughout.
4. Limit switches and gearing shall be an integral part of the pipe operator. The limit switch shall be totally enclosed in its own gear case and permanently grease or oil lubricated. Limit switches shall be provided at each end of travel. The switches shall be adjustable to allow the switch to trip at any point on the pipe's rotation. The limit switches shall be geared to the drive mechanism and in step at all times whether the unit is in motor or manual operation.
5. The pipe control shall be equipped with a double torque switch. The torque

switch shall be adjustable and shall be responsive to load encountered in either direction of travel. It shall operate during the complete cycle to protect the pipe should excessive load be met because of obstruction in either direction of travel.

6. The operator shall have a stem nut of high tensile bronze. The nut arrangement shall be of the two-piece type to simplify field replacement. The stem nut shall be capable of being removed from the top of the operator without the necessity of removing the operator from the floor stand or disassembling any of the gearing within the operator.
7. A handwheel shall be provided for manual operation. The handwheel shall not rotate during electric operation, but shall be responsive to manual operation at all times except when the motor is in operation. The motor shall not rotate during hand operation, nor shall a fused motor prevent hand operation. When in the hand operating position, the unit shall remain in this position until the motor is energized, at which time the operator shall automatically return to electric operation and shall remain in the electric position until hand operation is again desired. This movement from electric to hand operation shall be accomplished by a positive declutching lever which shall disengage the motor and motor gearing mechanically but not electrically. When in hand operation, not more than 40 lbs of force shall be required for handwheel operation. An arrow shall be cast on the handwheel labeled to indicate the direction of rotation to rotate the pipe. The direction of rotation to go forward shall be clockwise.
8. Furnish cast iron floor stands for operators. Provide a double-nut arrangement for leveling. Do not install non-shrink grout until after the unit is tested.
9. Control enclosures shall be FM certified and shall meet NEMA 3, 4X, and 6 requirements. Provide space heaters in each compartment to prevent condensation by maintaining space temperature of at least 60 degrees F.
10. Each operator shall be provided with integrally mounted electrical controls housed in the enclosure. The controls shall be completely factory wired to the motor, limit switches and torque switch such that the only field wiring connection required shall be for power supply and signal. All field wiring shall be to terminal strips.
11. The scum pipes shall be capable of automatic remote control and local manual control. Drive shall be capable of positioning the tipped elevation of the scum pipe by a 4-20 mA signal in both the forward and reverse direction.
12. Provide a LOCAL-OFF-REMOTE selector switch with REVERSE-FORWARD pushbuttons at the operator. The reverse and forward pushbuttons shall rotate the skimmer continuously while the pushbutton is depressed. Provide dry 10 Amps, 120 VAC contacts for remote indication that skimmer is in the "REMOTE" mode.
13. Local controls shall be located such that they are in a horizontal position and are easily accessible when standing at the operating level. Provide engraved

nameplates to identify all controls. Control circuits shall be 120 Volt, single phase, 60 Hz supplied by control transformer.

14. Provide and label red and green indicating lights on operator. Two red lights to indicate when skimmer is completely opened in either direction; green light, when skimmer is in normal vertical position. Both red and green lights on during operation at intermediate positions or when operator is stopped at any intermediate position. Provide separate lights for forward and reverse positions. Provide dry 10 Amps, 120 VAC contacts for each position for remote indication.

2.4 HARDWARE

- A. All field assembly bolts and anchor bolts, nuts, and washers shall be Type 316 stainless steel.

2.5 FABRICATION

- A. All welded joints that will be fully or partially submerged shall be sealed watertight with continuous welds. All welding shall be performed in accordance with AWS standards.
- B. All parts and components shall be factory-assembled in sections convenient for field handling and installation but requiring the minimum amount of work for field assembly. Any field assembly work shall be bolted. No cutting or welding should be required on either field assembly or erection.
- C. All assembled parts and components ready for shipment shall be securely bundled, coiled, or crated and adequately protected from damage and corrosion during shipment and storage.

2.6 SURFACE PREPARATION

- A. All stainless steel surfaces shall be brush blasted in accordance with SSPC-SP7 before shipment.
- B. Drive unit shall include manufacturer's standard wash down duty paint system.

2.7 SPARE PARTS

- A. Provide one manufacturer's standard preventive maintenance kit for equipment specified.
- B. Furnish one set of special tools required for maintenance or operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with manufacturer's instructions and recommendations.
- B. Anti-seize thread lubricant, which is NSF-61 approved, shall be applied to the male threads of all stainless steel bolts at the time of assembly.

3.2 WARRANTY

- A. The supplier shall guarantee in writing that the equipment furnished is appropriate for the intended service and shall be free of manufacturing and fabrication defects in material and workmanship for a period of 1 year after the equipment is satisfactorily placed in service. If the equipment is not placed in service within 6 months of delivery, the 1 year guarantee period shall commence 6 months after delivery.

3.3 MANUFACTURER'S FIELD SERVICE

- A. Provide manufacturer's services at the jobsite designated by the Owner for the minimum hours listed below, travel time excluded:
 - 1. Minimum 3-8 hr days (2 trips) for installation supervision, start-up and field testing services and O&M training services.
 - 2. The manufacturer shall provide start-up reports covering installation inspection and start up activities.
 - 3. The manufacturer shall provide operator training to all required plant personnel.
- B. After installation supervision and field testing services by the manufacturer, the contractor shall submit to the engineer, a certification letter on the manufacturer's letterhead and signed by the manufacturer certifying that the equipment was installed per the manufacturer's recommendations.
- C. Each jobsite visit shall be scheduled separately with minimum seven (7) calendar days notice prior to each visit. The service visit for operational training shall be scheduled in coordination with the Owner's operations staff and shall be at such times as requested by the Owner.
- D. Above services shall be provided by the manufacturer's qualified factory-trained service staff.

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SECTION 46 33 42

DIAPHRAGM-TYPE METERING PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for ferric chloride chemical metering equipment.

1.3 QUALITY ASSURANCE

- A. All equipment in this Section shall be furnished by or through a single supplier. The contractor shall be responsible for the design, coordination and proper operation of the entire system. Pumps shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer.

- B. The manufacturers shall be experienced in the design and construction of equipment for this purpose, and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than five (5) years.

- C. WARRANTY

- a. The Contractor shall provide from the equipment manufacturer an extended warranty for a period of 12 months after acceptance of the equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

1.4 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:

Provisional SCDB Ferric Feed Pump

1.5 SUBMITTALS

- A. Contractor shall submit shop drawings in accordance with General and Supplementary Conditions and Division 01.

- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.
- C. In addition to those submittals identified in the General and Supplementary Conditions and Division 01, the following items shall also be submitted:
1. Performance data curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guarantee point.
 2. Catalog data on pumps, motors, and all appurtenances.
 3. Certified pump curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guarantee point.
 4. Installation or placing drawings for equipment, drives and bases. Shop drawings for skid-mounted units showing general arrangement, weights, and dimensions, with a complete bill of materials listing all components.
 5. Suggested spare parts list with current price information.
 6. List of special tools required for checking, testing, parts replacement, and maintenance. (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.)
 7. List of materials and supplies furnished with the equipment.
 8. Requirements for storage and protection prior to installation.
 9. Requirements for routine maintenance required prior to plant startup.
 10. Motor submittals shall include manufacturer's catalog information, motor drawings and operating characteristics, nameplate data and efficiency characteristics, and maximum starts per hour. Wiring diagrams shall be provided showing power and control wiring terminal connections including wiring identification and color coding. Junction box sizing for power and control wiring connections shall be provided. Information shall indicate compliance with requirements specified in the Section entitled "Miscellaneous Electric Motors."

D. Electrical Submittal Information

1. Submittals for equipment, control panel, and materials shall be clearly marked or noted with specific features, standard options, and wiring diagrams to indicate compliance with Contract Documents, Including terminal board wiring, diagrams including terminal numbers and conductor color codes for stator leads.
2. Where deviations to Contract Documents are proposed, submit a list of deviations. Provide a detailed description and explanation for each deviation.
3. Shop drawings shall present complete and accurate information relative to all working dimensions, equipment weights, assembly, and section views, and all necessary details pertaining to coordinating the Work of the Contract. Shop drawings shall contain information such as special tools and other items of information that are required to demonstrate detailed compliance with the Contract Documents.
4. Submit shop drawings, which shall include the following:
 - a. Bill of Materials for all equipment and accessories.
 - b. Manufacturer's catalog information for all components and accessories.
 - c. Manufacturer's standard wiring diagrams including all available terminal connections.
 - d. Project specific wiring interconnection diagrams showing all field termination points to remote equipment.
 - e. Spare Parts List (including specified spare parts to be furnished by the Contractor and manufacturer's recommended spare parts list for each type of unit).
 - f. Project specific installation instructions and mounting details for each component. Materials of construction for supports, brackets, and mounting hardware shall be provided with details.

E. Manufacturer's installation recommendations and instructions for the pumps.

F. Submit Operation and Maintenance Manuals in accordance with General and Supplementary Conditions and Division 01.

G. Submit Manufacturer's certification that all materials furnished are in compliance with the applicable requirements of this Specification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND SYSTEM SUPPLIERS

A. The project Basis of Design is UGSI Chemical Feed Encore Series as described in this Section.

B. Acceptable manufacturers:

1. UGSI Chemical Feed (Encore 700)

2.2 GENERAL

- A. The pumps shall be mechanically-actuated diaphragm type capable of withstanding aggressive chemicals. Pump materials shall be as specified or the manufacturer shall submit evidence of chemical resistance if the materials of construction are different than those individually specified herein. The flow produced by the pump shall be constant and independent of the system's discharge pressure or changes in the discharge pressure.

2.3 PERFORMANCE REQUIREMENTS

- A. The pump shall be designed to comply with the following minimum design conditions:

1. Provisional SCDB Ferric Feed Pump

<u>Parameters</u>	<u>Value</u>
No of Pumps Required	1
Capacity/pump	
Design Flow	8 gph
Minimum Pressure Rating at Design Flow	100 psi
Pump Rated Discharge Pressure (Maximum)	175 psi
Liquid Pumped	Ferric Chloride, 35%
Valve Seat	PVDF
Valve Cap & Guide	PVDF
O-Rings	Hypalon (CSM)
Reagent Head	PVDF
Diaphragm	Composite TFE faced Elastomer
Balls	Ceramic
Motor Rating	½ HP
Drive Type	Pulley Drive, Inverter Duty
Power Requirements	230/3ph/60HZ
Motor Enclosure:	Explosion Proof, suitable for installation in Class I, Group D, Division 1 Hazardous Locations

- B. A steel and nodular iron non-loss-motion stroke adjust mechanism, driven by a pulley coupled, inverter duty motor shall actuate a flat, Teflon-faced composite diaphragm.
- C. The liquid ends shall provide for easy maintenance via PVDF cartridge type check valves.

- D. Drive
1. A steel and nodular iron non-loss-motion stroke adjustment mechanism shall be housed in a corrosion resistant, epoxy painted, cast iron gearbox.
 2. All Drive bearings shall be tapered rollers, all fasteners shall be stainless steel.
 3. The gearbox shall be oil-bath lubricated.
 4. Stoke Length shall be controlled manually via a 10-turn micrometer type adjuster.
 5. A percent scale and vernier shall indicate stroke and length in 0.25% increments.
 6. Each revolution of the know shall change the stroke length by 10%
- E. The diaphragm shall be Teflon-faced, fabric reinforced and bonded to pre-formed elastomeric support. It shall incorporate convolutions, for unconstrained rolling action and a steel backing plate for volumetric accuracy. An o-ring groove in the head's diaphragm cavity will provide for a leak free seal.
- F. Positive flow shall be ensured via cartridge type check valves.
- G. The valve retainers shall be Kynar and shall compression seal to the pump head and pip connectors via o-rings.
- H. Valve service or removal shall not require any disturbances to the pump head pipe works.
- I. A secondary diaphragm shall completely seal and separate the pump head from the drive unit, to eliminate any risk of cross-contaminating the gearbox lubricant and process fluid.
- J. Configuration
1. The design shall be capable of multiplexing two gearboxes, each with independent capacity control.
- K. A diversion port shall be provided in the pump casing behind the diaphragm for drainage of pumped product in the event of an unlikely diaphragm failure.
- L. Flow adjustment shall be from 0 to 100% with a guaranteed accuracy of + 2% steady state on set point over a 10:1 flow turndown range and up to (or above) 200:1 when the pump is used with the MPC.
- M. Once primed, the pump shall have a suction lift capability of at least 10 feet of water.
- N. The pump shall have the ability to be hydrostatically tested in the actual installation at 1.5 times the rated pressure of the pump to ensure a safe environment.

2.4 METERING PUMP CONTROL

- A. Control
 - 1. Feed rate shall be controlled manually, via a 10 turn micrometer-type stroke length adjuster.
 - 2. A percent scale and vernier shall indicate stroke length in 0.25% increments.
 - 3. Each revolution of the knob shall change stroke length by 10%.
 - 4. Feed rate shall be infinitely adjustable from 0 through 100%.
 - 5. Stroke length shall be adjustable over a 10:1 operating range.
 - 6. Repeatable metering accuracy shall be $\pm 2\%$ of full scale, at constant hydraulic conditions, over the operating range.
 - 7.
- B. The pump controller shall be integrally mounted in a NEMA 8 enclosure.
- C. The pump controller shall be supplied by the metering pump manufacturer.
- D. Motor Requirements: An inverter-duty motor shall be selected and supplied by the manufacturer of the pump.

2.5 ACCESSORIES

- A. Each chemical feed system shall be completely assembled, mounted, calibrated, factory-tested, and delivered to the site on a single skid. Components to be mounted on the skid shall include metering pumps, piping, valves, piping accessories (pulsation dampeners, back pressure valves, pressure relief valves, etc. as detailed in the drawings), and wiring integral to the skid. The chemical metering pump manufacturer shall be responsible for providing the complete skid package and shall be responsible for all equipment, valves and piping within the skid boundary.
- B. Chemical feed skids shall be constructed of High Density Polyethylene (HDPE).
- C. For PVC piped systems, clear PVC piping shall be used between the Y-Strainer and pump suction valve. This will allow a visual inspection of the liquid in the injection line during operation. Additionally, clear PVC piping shall be used from the pressure relief valve back to the suction piping to allow visual verification of relief flow.
- D. All PVC piping and fittings shall be schedule 80 and readily available locally. Special machined fittings/blocks that are not of standard manufacture will not be accepted.
- E. Feed system piping shall include an air bleed/flush connection on the suction and discharge of each pump. The bleed/flush connections should be located on the interior of the pump isolation valves to allow for all lines to be purged of air after the bulk tank or tote is filled and allow the pump to be flushed prior to maintenance being performed.
- F. Chemical feed system design shall be such that the wetted end of the pump is orientated at the open end of the framework for easy access. Systems designed with the wet-end of the pump facing the vertical wall (rear) or side of the skid will not be accepted.

- G. Each pump shall be provided with discharge pulsation dampener. The pulsation dampener shall be sized to allow a maximum of +/- 5% pressure oscillation. The pulsation dampener should be located 12" or closer to the pump discharge and provided with union connection.
- H. Backpressure valves shall be of the in-line diaphragm design. Backpressure valve shall be set at 40 psig from the factory and provided with union connections. Once in the field the backpressure valve should be set at 10-20 psig above injection pressure.
- I. Pressure Relief Valve shall be a 3-way diaphragm design with bottom relief and in-line connection. Pressure relief valve shall be set at 100 psig from the factory and provided with union connections. Pressure relief valve shall be field adjustable.
- J. On multiple pump systems, there shall be one calibration column per pump such that one pump can be calibrated while the other pumps are fully operational. Chemical feed systems employing only one calibration column per skid are not acceptable.
- K. All components of the skid-mounted system (pumps, piping and controls) shall be factory pressure tested with water prior to shipment. Certification of factory testing shall be included in installation, operation and maintenance manuals.
- L. The metering pumps shall use unions on the suction and discharge of the pump in order to allow removal of the pump without disturbing the suction or discharge piping.
- M. All piping / accessory support shall be from skid base or rear panel. Piping / accessory support from above is not acceptable.
- N. The metering system shall incorporate 2" liquid filled gauges on the discharge of the pump. Each gauge shall be protected by a glycerin filled gauge protector that is capable of operation from 25" Hg to 150 psig. The discharge gauge shall be 0-200 psig. The casings of the gauge shall be stainless steel and accuracy shall be 2% or better.
- O. Gauge assemblies shall incorporate a ½" gauge guard on the liquid side of the pressure gauge and shall be provided with union connections so that they may be removed / maintained while the feed system is fully operational.
- P. All piping accessories shall be securely fastened to the frame or supported with stand-offs. The use of steel bands or strapping shall not be acceptable.

2.6 SPARE PARTS

- A. Provide one manufacturer's standard preventive maintenance kit for each size of equipment specified.
- B. Furnish one set of special tools required for maintenance or operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with manufacturer's instructions and recommendations.
- B. All buried chemical piping shall be a minimum of 3.0 feet below grade.
- C. All vent lines in the chemical pump rooms shall be clear PVC to an elevation of 6.0' above the finished floor elevation. All vent lines shall be Schedule 80 PVC pipe.

3.2 FIELD TESTING

- A. Field inspection and testing shall be performed for the diaphragm type metering pumps as follows:
 - 1. Pre-test Checkout
 - a. Adjust, test and calibrate all controls, switches, drive units, and other instrumentation and control equipment associated with the equipment specified in this Section.
 - b. System supplier shall have inspected the system, and certified proper installation and adjustments, either prior to or concurrent with the Pre-test Checkout.
 - 2. Performance Test
 - a. Verify specified metering pump capacity; the calibration standpipe shall be used in conjunction with no less than three individual one-minute drawdowns. Use potable water for all chemical metering testing.
 - b. In MANUAL mode, demonstrate control of variable stroke settings and variable speed, and pump to the various discharge points as indicated on the Contract Drawings.
 - c. Demonstrate function of pressure relief valves, pressure gauges and flow indicators.
 - d. In AUTO mode, demonstrate proper function of the feed pump control panel. Adjust the ratio setpoint and the bias setpoint to produce the correct chemical feed rate. Testing shall be performed in the presence of a manufacturer's representative.

3.3 MANUFACTURER'S FIELD SERVICE

- A. Provide manufacturer's services at the jobsite designated by the Owner for the minimum hours listed below, travel time excluded:
 - 1. 8 hours for installation assistance, inspection, and certification of installation.
 - 2. 8 hours for performance testing.
 - 3. 4 hours (1 trip) for operational training (minimum 1 session)
- B. Each jobsite visit shall be scheduled separately with minimum seven (7) calendar days notice prior to each visit. The service visit for operational training shall be scheduled in coordination with the Owner's operations staff and shall be at such times as requested by the Owner.
- C. Above services shall be provided by the manufacturer's qualified factory-trained service staff.

* * * * *

SECTION 46 53 33.1

INTEGRATED FIXED FILM ACTIVATED SLUDGE EQUIPMENT - INSTALLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The Integrated Fixed Film Activated Sludge (IFAS) System will be used to treat screened primary clarifier effluent.
- B. Install, test, startup and place into satisfactory service all IFAS System Equipment furnished by the Owner under Contract 1. Equipment includes control panels and field instrumentation.
- C. Reference Contract 1 documents for product details of pre-purchased equipment to be installed.

1.3 RELATED SECTIONS

- A. Related Sections include the following:
 - 1. Division 9
 - a. Section "Painting"
 - 2. Division 26
 - a. Section "Packaged System Control Panels"
 - 3. Division 40
 - a. Section "Common Work Results for Process Integration"
 - b. Section "Butterfly Valves Three Inches and Larger"
 - c. Section "Plug Valves Three Inches and Larger"
 - d. Section "Electrically-Operated Primary Control Valves"
 - e. Section "Pressure Gauges"
 - f. Section "Instrumentation General"
 - 4. Division 43
 - a. Section "Vertical Non-Clog Centrifugal Pumps – Installation"
 - b. Section "Positive Displacement Rotary Lobe Blowers – Installation"

1.4 EQUIPMENT IDENTIFICATION

- A. Systems installed under this specification are identified as follows:
 - Integrated Fixed Film Activated Sludge System (IFAS) Bioreactors: 1, 2, 3
 - IFAS System Control Panel

- IFAS System Control System Workstation

1.5 SUBMITTALS

A. Certifications:

1. Certification of Proper Equipment Installation - Submit written certification by the IFAS System supplier's representative of proper equipment installation following field inspection and prior to testing and startup.
2. Certification of Equipment Testing and Startup - Submit written certification from the IFAS System supplier's representative verifying successful function testing.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Installing Contractor shall refer to Contract 1 Documents for Products supplied by the Owner / IFAS System Supplier.

PART 3 - EXECUTION

3.1 GENERAL

- A. The installation of the equipment furnished by the Owner (IFAS System Supplier Contract 1a) shall be by the Installing Contractor.
- B. Installing Contractor shall refer to the Contract 1 shop drawings for manufacturer's installation instructions for equipment to be installed under this specification.

3.2 SCHEDULE

- A. The following summarizes the delivery and installation schedule requirements for Contract 1. The Installing Contractor shall coordinate his work accordingly to meet these deadlines.

ACTIVITY	FINISH DATE
Contract 1 Equipment and (1/3) Media Delivery ⁽¹⁾⁽²⁾	1/14/2016
Contract 1 (2/3) Media Delivery ⁽¹⁾⁽²⁾	10/14/2016
Equipment Installed and Ready for Testing	1/13/2017 to 2/7/2017
Process Performance Testing Complete (Initial)	4/7/2017
Equipment Procurement Contract Complete	6/9/2017

1. Liquidated Damages will apply per Contract 1a Special Conditions SC-8 for failure to complete specified tasks within the time frame established in Contract 1a Special Conditions SC-3.
2. The Owner shall notify the System Supplier of the exact delivery dates after coordination with the Installing Contractor.
3. Note that General Construction NTP is anticipated on 1/1/2016.

- B. If delivery to the jobsite of Owner furnished items are delayed through no fault of the Installation Contractor, the Installing Contractor shall be entitled to request a time extension equal to the number of work days from the originally scheduled delivery date to the date the items arrive to the jobsite. The Installing Contractor shall not be entitled to any additional compensation related to early or late delivery of items to be furnished by the Owner.
- C. The Installing Contractor shall notify the Owner as to when within the Equipment Delivery window the Contractor would like to receive the Contract 1 equipment at the jobsite. Notification shall be made a minimum 8 weeks prior to the start of the equipment delivery window.

3.3 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall store and protect equipment specified herein in accordance with the requirements of Division 01.
- B. The IFAS System Supplier (Contract 1) will furnish and deliver all equipment, freight pre-paid, to the jobsite.
- C. Installing Contractor shall unload equipment furnished under Contract 1 at the jobsite.
- D. Installing Contractor shall protect materials and equipment from exposure to the elements and keep dry at all times. Handle, maintain and store to prevent damage and in accordance with manufacturer's recommendations.
- E. Refer to Contract 1 shop drawings for proper handling, maintenance and storage instructions.
- F. Material and equipment damaged by handling by the Installing Contractor shall be repaired or replaced by the Installing Contractor as directed by the Engineer at no additional cost to the Owner.

3.4 COMPONENT INSTALLATION AND FIELD TESTING

- A. Installing Contractor shall perform installation, testing, and startup of Contract 1 equipment.
- B. Refer to the following specification sections in the Contract Documents for installation, testing, and startup requirements for products supplied under Contract 1a:
 - 1. "Electric Motors"
 - 2. "Common Work Results for Process Integration"
 - 3. "Butterfly Valves Three Inches and Larger"
 - 4. "Plug Valves Three inches and Larger"
 - 5. "Pressure Gauges"

6. “Electrically-Operated Primary Control Valves” for motor operated valves assemblies.
 7. “Tests on Pumping Equipment”
 8. “Medium Coarse Bubble Aeration System”
 9. “Submersible Mechanical Mixers”
 10. “Integrated Fixed-Film Activated Sludge System”
- C. Refer to Contract 1 shop drawings for additional requirements for system component installation, inspection, testing, and startup.

3.5 IFAS SYSTEM FIELD TESTING

- A. Installing Contractor shall perform field testing of the IFAS system after components have been installed and tested.
- B. IFAS System Manufacturer’s representative will provide field services as outlined in Contract 1. Installing Contractor shall be responsible for coordinating these field services.
- C. Refer to Contract 1 shop drawings, Section 9, for system inspection and start-up requirements. Please follow the IFAS System Supplier for instructions on completing the required documentation.

3.6 MANUFACTURER’S FIELD SERVICE

- A. The IFAS System Supplier will provide the services necessary to start-up, test, and operate the system as follows:
1. Advice to Installing Contractor during installation
 2. Equipment check-out and start-up assistance
 3. Operator training
 4. Follow-up site visits
- B. Installing Contractor shall coordinate manufacturer’s field services with the Owner based on installation and startup schedule. The Installing Contractor shall provide the Owner / manufacturer 4 weeks notice to schedule any inspection or start-up trips.

3.7 FIELD PAINTING

- A. Field painting shall be by the Installing Contractor in accordance with the Section entitled “Painting.” Refer to the Contract 1 shop drawings for any shop painting provided by the equipment manufacturer. Installing Coordinate shall coordinate field painting as required.

SECTION 46 61 41

DISC CLOTH FILTERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 26 Electrical
- C. Motors shall conform to requirements of Division 26 Section “Common Motor Requirements.”
- D. Control Panels shall conform to requirements of Division 26 Section “Packaged System Control Panels.”

1.2 SUMMARY

- A. Furnish, install, and start up equipment for the four (4) disc type cloth media filters as shown on the Drawings and/or specified herein.
- B. The Contractor shall furnish and install all equipment and accessories and provide all necessary services for the equipment as specified herein. The scope of work shall include four (4) disc type cloth media filters in which each disc filter shall include a central drum onto which the discs with the filter media panels are assembled. The rotating filter drum shall be supported on the front and rear ends by sleeve bearings. Each filter unit shall include center drum, discs with filter media panels, support frame with integral backwash clearwell and effluent level control, cover over the entire filter, backwash spray assembly and pump, backwash trough, drive mechanism, automatic control system, and components as specified.

1.3 QUALITY ASSURANCE

A. GENERAL

- 1. The Contractor shall be responsible for ensuring that all equipment installed is properly connected to other related equipment for proper functioning of the plant.

B. PERFORMANCE TESTING

- 1. Once Manual and Automatic Control has been successfully demonstrated and the filter influent is in conformance with the design values for flow, TSS, and Total Phosphorus, one (1) daily composite sample shall be collected and tested by the Owner immediately upstream and downstream of the filter for five consecutive days. Each sample shall be analyzed for Total Suspended Solids and Total Phosphorous in mg/L. These tests should be completed for one filter at a time. In the event of the continued failure of the equipment to produce the specific effluent characteristics at no fault of the Owner, the filter Manufacturer shall

have the option to modify the filter(s) as necessary to achieve the specified performance.

C. WARRANTY

1. The Contractor shall provide from the equipment Manufacturer an extended warranty for a period of 12 months after acceptance of equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event that the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

D. MANUFACTURER'S QUALIFICATIONS

1. The Manufacturer of work of this Section shall have five (5) years minimum proven experience in such work and shall have satisfactorily completed three (3) jobs of similar size and type within the last five (5) years

1.4 EQUIPMENT IDENTIFICATION

A. Equipment covered under this Specification is identified as follows:

1. Disc Filter No. 1
2. Disc Filter No. 2
3. Disc Filter No. 3
4. Disc Filter No. 4

1.5 REFERENCES

- A. American Gear Manufacturers Association (AGMA)
- B. American Iron and Steel Institute (AISI)
- C. American Society of Testing and Materials (ASTM)
- D. American Welding Society (AWS)
- E. National Electrical Manufacturers Association (NEMA)

1.6 SUBMITTALS

- A. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:
 1. All required structural design calculations shall be prepared by the manufacturer and sealed by a professional engineer registered in the State of Ohio.

2. Manufacturer's literature, illustrations, specification, and engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.
 3. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
 4. Operation and Maintenance manuals of the Disc Cloth Filters.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other non-conformities.
- C. Submit Operations and Maintenance Manuals in accordance with the General and Supplementary Conditions.
- D. Submit Manufacturer's Certificate in accordance with the General and Supplementary Conditions.

1.7 STORAGE AND PROTECTION

- A. Store and protect the disc cloth filters and accessories in accordance with the requirements of Division 01.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. All of the equipment specified under this Section shall be furnished by a single supplier, who is fully experienced and qualified in the manufacture or supply of the equipment specified. The equipment shall be provided by one of the following Manufacturers:
1. WesTech Engineering, Inc.
 2. Kruger, Inc.
 3. Or approved equal

2.2 SYSTEM PERFORMANCE

- A. The Disc Cloth Filter System shall be capable of the following hydraulic requirements:

1.	Peak Flow Rate 3 filters in service, 1 in standby	22.0 MGD (15,278 gpm)
2.	Average Flow Rate 3 filters in service, 1 in standby	17.0 MGD (11,805 gpm)

3.	Maximum Loading Rate 3 filters in service, 1 in standby	3.73 gpm/ft ²
4.	Maximum Head Loss at Peak Flow Rate Prior to Backwash 3 filters in service, 1 in standby	12 inches

- B. The Disc Cloth Filter System shall be capable of the following performance requirements without the use of chemical coagulant feed:

1	Peak Influent TSS at Average Daily Flow	40 mg/L
2	Monthly Average Influent TSS at Average Daily Flow	20 mg/L
3	Monthly Average Influent Total Phosphorus at Average Daily Flow	0.8 mg/L
4	Monthly Average Effluent TSS at Average Daily Flow	≤ 5 mg/L
5	Monthly Average Effluent Total Phosphorous* at Average Daily Flow	≤ 0.4 mg/L

* Influent average soluble phosphorous is less than 0.2 mg/L and particulate P:TSS ratio ≤ 0.04

- C. The Disc Cloth Filter System shall be capable of the following performance requirements with the use of chemical coagulant feed:

1	Peak Influent TSS at Average Daily Flow	15 mg/L
2	Monthly Average Influent TSS at Average Daily Flow	10 mg/L
3	Monthly Average Influent Total Phosphorus at Average Daily Flow	0.8 mg/L
4	Monthly Average Effluent TSS at Average Daily Flow	≤ 5 mg/L
5	Monthly Average Effluent Total Phosphorous at Average Daily Flow	≤ 0.3 mg/L

2.3 DESIGN PARAMTERS

- A. Design parameters for the Disc Cloth Filters are as follows:

Filter Design Data		
1.	Number of Units	4
2.	Filter Pore Size	10 mm
3.	Filter Cloth Material	Polyester
4.	Minimum Number of Filter Discs Per Unit	30

5.	Minimum Filter Disc Diameter	2.4 Meters
6.	Minimum Effective Filter Surface Area Per Unit	1362 ft ²
Filter Drive Unit		
1.	Drive Motor (1 Per Unit)	3 HP, 460V, 3 ph
2.	Drive Assembly	Carbon synchronous belt and 304 SS sprocket
Backwash Cleaning System		
1.	Minimum No. of Backwash Nozzles (Per Disc)	12
2.	Backwash Pump (1 Per Unit)	25 HP, 460V, 3ph
3.	Minimum Backwash Pressure	110 psi
4.	Minimum Backwash Flow Rate	235 gpm
5.	Spray Bar Oscillation Motor (1 Per Unit)	0.25 HP, 460V, 3ph

2.4 GENERAL

- A. The disc cloth filter system shall be suitable for filtering municipal wastewater from an activated sludge facility following secondary clarification. The disc cloth filter system shall meet the performance requirements as stated above with at least one filter out of service. Each filter in service shall be designed to operate on a continuous basis and shall be designed to operate while receiving varying flows.
- B. Filtration system shall utilize an "inside-out" flow pattern where influent flows by gravity into the filter discs from the center drum. Solids shall be separated from the water by partially submerged filter media. Filtration systems with fully submerged media utilizing an "outside-in" flow pattern shall not be acceptable due to accumulation of solids in the tank.
- C. The maximum number of discs possible for each unit shall be provided by the Manufacturer, installed, and placed into satisfactory operating condition.

2.5 MATERIALS AND EQUIPMENT

- A. The disc filter shall be shop fabricated, fully assembled, and tested prior to shipment. Connections and mechanism supports shall be oriented as shown on the Drawings.
- B. All fabricated metal shall be AISI 304 stainless steel. All welding shall conform to the latest standards of the American Welding Society. Filter panels shall be of polyester filter cloth chemically welded to a SMC compression molded cassette.
- C. All flanges, flange rings and collar rings shall be stainless steel. All anchor bolts shall be stainless steel.
- D. All pressure gauges shall be furnished and installed with stainless steel nipples.
- E. The valves, equipment, materials of construction and controls specified under this Section supersede valves, equipment, materials of construction and controls specified elsewhere in these Specifications. Purchased components such as gear reducers, pumps, motors, valves, and actuators shall be provided with standard recommended Manufacturer's paint, unless otherwise specified within these Specifications.

2.6 CENTER DRUM

- A. The center drum shall be water tight, one piece, structural welded, 304 stainless steel fabricated piece that is open at one end to allow the influent to enter, and has openings to the filter discs for water distribution to the filter media. The center drum shall have lubricated bearings, which are externally accessible for routine lubrication.

2.7 DISC ASSEMBLY

- A. The filter shall be composed of removable discs. Each disc shall consist of individual cassette segments that can be easily installed or removed as required. Each individual filter cassette shall be bolted into the center drum with stainless steel hardware.
- B. The filter cassettes shall be constructed from SMC compression molded cassette of fiber-reinforced polyester. The filter panels (filter media) shall be permanently attached to the individual filter cassettes. The filter media shall be a precision woven, open mesh, PET, monofilament fabric.
- C. Nominal media pore size shall not exceed 10 microns.
- D. The replacement of filter media must be possible from outside of the filter tank by unfastening a single bolt and sliding the cassette from the disc assembly.

2.8 FILTER COVER

- A. The upper part of the filter shall be furnished with a cover fabricated from glass fiber-reinforced plastic (FRP). These filter covers shall be hinged and operate as lids that can be opened for disc filter service and inspection.
- B. The cover shall be automated to allow it to open. Two magnetic motor actuators shall open and lift the cover. The actuators must meet IP66 classification for outdoor use and IP69K classification for washdown duty. The motor actuators must include mechanical overload protection via integrated slip clutch and shall include a hand crank for manual operation. Manual operation must only be performed while the power supply is disconnected.
- C. Color of the filter cover shall be selected by the Owner.

2.9 BACKWASH CLEANING SYSTEM

- A. Each disc cloth filter shall be equipped with a single traversing back-washing system with moving spray headers, driven by a gear motor for efficient cleaning of the filter media. The gear motor shall be a shaft-mounted, helical worm gear with integral standard AC induction motor. The motor shall be standard efficiency TEFC rated for 0.25 HP, 460V, 1 phase, 60 Hz operation.
- B. The backwash system shall be comprised of 304 stainless steel or ceramic backwash spray headers installed between the discs. The spray headers shall rotate out for easy accessibility, requiring no disassembly and shall be operated by a cam system. Each backwash header shall have flat pattern spray nozzles for each disc side. The spray

nozzles shall consist of ceramic nozzle tips, mounting caps for quick removal, nozzle body and seals. The nozzle system shall be Spraying Systems, Co., Quick TeeJet, or approved equal.

- C. Each disc filter shall have one 25 HP externally mounted low-pressure, vertical multistage, Grundfos MTR 45-8/5 immersible centrifugal pump. Filtered water shall be pumped via a 304 stainless steel suction pipe and discharged from the pump to the 304 stainless steel discharge piping.
- D. Each filter shall be equipped with either a submersible pressure transducer or conductance probe for influent water level measurement. The backwash cycle shall be activated by either elevated influent water level (as indicated by the signal from the sensor) or by manual operation.
- E. Each filter shall be equipped with either a submersible pressure transducer or conductance probe for effluent water level measurement and shall be the same type and model as the influent sensor. The effluent water level signal will be used by the filter unit control system to prevent dry-running of the backwash pump.
- F. The disc filters shall have a collection trough for the removal of solids during the backwash cycle. The backwash trough shall be constructed of 304 SS. The length of the backwash trough shall be equivalent to the length of the center drum and isolated from the influent stream. The collected solids and backwash water shall leave the backwash collection trough via gravity to the backwash outlet connection. The backwash outlet connection shall be a 6-inch stainless steel loose flange.
- G. A drive assembly is incorporated to rotate the center tube/disc assembly during the backwash cycles. The disc filter drive system shall consist of a gear motor, Gates Polychain Carbon 37 mm synchronous drive belt and a 304 SS sprocket. The gear motor shall be SEW Eurodrive shaft-mounted helical worm gear with integral standard AC induction motor. The motor shall be premium efficiency, TEFC-rated for a 3 HP, 460V, 3 phase, 60 Hz operation.

2.10 AUTOMATIC CLEANING SYSTEM

- A. The system will be designed to connect via hose to a chemical spray header installed within the disc filter unit. The pump will connect via 480V receptacle to the local control panel for the filter unit. Contractor shall coordinate with the Manufacturer location and distances from the local control panels to the automatic cleaning system to ensure adequate hose and electrical cord is provided to perform cleaning on each of the filter units. The local control panel will allow for operator initiation of the chemical clean process. Once initiated, the control panel will provide automatic operation and control of the cleaning system process. The system will include:
 - 1. 25 gallon polyethylene tank mounted on a movable tray
 - 2. Magnetic drive centrifugal spray pump
 - 3. Manual ball valves, manometer, schedule 80 PVC piping, and chemical resistant hose. Ball valves shall be suitable for the chemicals used and be equipped with venting for use with sodium hypochlorite.

2.11 CONTROL PANELS AND OPERATION

- A. Each disc cloth filter operation shall be managed by an automated control system. One (1) control panel shall be provided for each filter unit. The control panels shall be mounted separately from the disc filter system and shall be provided in a NEMA 4X, 304 SS enclosures. Each disc filter unit shall include a control system which shall consist of a programmable controller, fused main disconnect, control transformer, branch circuit breakers, IEC motor starter/protector, hand-off-automatic switches, and liquid level sensor relay for initiating backwash. The power feed to the control panels shall be 480 VAC, 60 Hz, 3 phase, control voltage shall be 120 VAC, 60 Hz, 1 phase. Control panel PLC shall be by Allen Bradley.
- B. The disc filter backwash cycle is initiated either manually by a HOA switch or automatically by monitoring the water level in the center drum with a level sensor, located in the influent chamber. The level sensor is wired to a liquid level relay located in the disc filter control panel. The liquid level relay is activated when the level sensor comes in contact with water in the influent chamber.
- C. Each filter will be supplied with a high level sensor. The high level sensor will be mounted in such a way to ensure that the device indicates when the water reaches a height above the backwash level sensor and has entered a high level scenario. When the high level sensor is activated, it will activate a relay inside the control cabinet and a pilot light on the front of the control panel will illuminate. The high level relay will have a spare set of normally open dry contacts available for monitoring.
- D. A VFD located in each disc filter control panel will manage the start/stop of the Filter Drum motor. The VFD will be sized appropriately to match the requirements of the Filter Drum motor. The VFD will be equipped with an integral keypad display for the VFD interface and configuration, use sensorless flux vector technology, use with 3-phase asynchronous motors, monitoring and control inputs and outputs, motor and drive protection. The VFD will not require input/output filters or harmonious testing.
- F. Each disc filter shall be equipped with SCADA signals (dry contacts) for the following:
 - 1. Disc Filter Auto Status
 - 2. Backwash Pump Run Status
 - 3. Backwash Pump Fault Status
 - 4. Disc Filter Motor Run Status
 - 5. Disc Filter Motor Fault Status
 - 6. Disc filter High Level Alarm
- G. Each control panel shall have external pilot lights mounted on the door indicating:
 - 1. Filter Run Status

2. Backwash Pump Status
 3. High Level Alarm
- H. The completed control panels shall be UL labeled per UL508A. The completed control panels will be factory tested and configured.
- I. Each control system will be supplied with one operator interface. The operator interface will be capable of interacting with the programmable controller. The operator interface shall be a color touch panel display of not less than 6 inches, be capable of displaying text and graphics, allow operator set point entry, and provide system status display.
- J. Each control system will allow for continuous backwashing while in HAND mode.

2.12 SPARE PARTS

- A. The following spare parts will be provided.
1. Twenty (20) Backwash Spray Nozzles
 2. Twenty (20) Filter Panels

PART 3 – EXECUTION

3.1 INSTALLATION

- A. The Contractor shall install the disc filter system per the Manufacturer's directions and the Drawings. The Contractor will provide all supports and anchoring required to install each disc filter unit. The plumbing/interconnecting piping, electrical connections, grating, and handrails shall be provided by the Contractor as detailed on the Drawings and the Specifications, including winterization such as piping insulation or heat tracing.

3.2 TOUCH UP COATING

- A. Touch up all damaged surfaces per the Manufacturer's recommendations.

3.3 FIELD SERVICE

- A. The Manufacturer shall furnish the services of a factory-trained representative to inspect the installation, start-up, and operation of the filter and provide training to Owner's personnel after the system is operational. The representative shall be on-site for installation inspection, start-up, and operator training for a period of four (4) days total, to be conducted in the span of no more than two (2) separate trips.

SECTION 46 71 13

CIRCULAR GRAVITY THICKENERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Furnish, install, and start up equipment for the circular gravity thickener equipment as shown on the Drawings and/or specified herein.
- B. The Contractor shall furnish and install all equipment and accessories and provide all necessary services for the equipment as specified herein. The scope of work shall include a center drive unit and torque control, walkway and platform with handrail, stationary center column, feedwell, drive cage, rake arms with pickets, launders, weir, launder covers, anchor bolts, and all other appurtenances required or shown on the drawings.

1.3 QUALITY ASSURANCE

A. GENERAL

- 1. The Contractor shall be responsible for ensuring that all equipment installed is properly connected to other related equipment for proper functioning of the Plant.

B. WARRANTY

- 1. The Contractor shall provide from the equipment Manufacturer an extended warranty for a period of 12 months after acceptance of equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event that the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

C. MANUFACTURER'S QUALIFICATIONS

- 1. Equipment and materials provided under this Section shall be the standard product in regular production by Manufacturers who shall have at least five years experience in the design and fabrication of the equipment as described herein, used for similar applications and shall have at least five installations of similar size and type within the last 5 years.

1.4 EQUIPMENT IDENTIFICATION

- A. Equipment covered under this specification is identified as follows:

1. Pre-Thickening Tank No. 1
2. Pre-Thickening Tank No. 2

1.5 REFERENCES

- A. American Federation of Bearing Manufacturers Association (AFBMA)
- B. American Gear Manufacturers Association (AGMA)
- C. American Iron and Steel Institute (AISI), Heat Treated Steel Specifications
- D. American Society for Testing and Materials (ASTM)
- E. American Welding Society (AWS)
- F. National Electrical Manufacturers Association (NEMA)
- G. Steel Structures Painting Council, American National Standards Institute (SSPC)

1.6 SUBMITTALS

- A. Provide submittals in conformance with the General and Supplementary Conditions, including the following items:
 1. All structural design calculations shall be prepared by the manufacturer and sealed by a professional engineer registered in the State of Ohio.
 2. Manufacturer's literature, illustrations, specifications, and engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.
 3. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.
 4. Electrical wiring diagrams clearly indicating the required field-wiring connections.
 5. Operation and Maintenance manuals of the Circular Gravity Thickeners.
- B. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor non-conformities, and detailed explanation of other non-conformities.
- C. Submit Operations and Maintenance Manuals in accordance with the General and Supplementary Conditions.

- D. Submit Manufacturer's Certificate in accordance with the General and Supplementary Conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All of the equipment specified under this Section shall be furnished by a single supplier, who is fully experienced and qualified in the manufacture or supply of the equipment specified. The equipment shall be provided by one of the following Manufacturers:
1. WesTech Engineering, Inc. (Salt Lake City, UT)
 2. ClearStream Environmental, Inc.
 3. Monroe Environmental, Inc.
 4. Or approved equal.

2.2 DESIGN REQUIREMENTS

- A. The existing tanks where the Circular Gravity Thickeners will be installed have the following physical dimensions:

1.	Number of Tanks	2
2.	Tank Diameter	49 ft.
3.	Side Water Depth	10 ft.
4.	Freeboard	1.5 ft.
5.	Surface Area, Per Tank	1,886 ft ²
6.	Bottom Slope	2.75":12"

- B. Design criteria for the Circular Gravity Thickeners are as follows:

1.	Maximum Influent Flow Rate	590,868 gpd (410 gpm)
2.	Maximum Sludge Production Rate	47,566 lb/day
3.	Maximum Solids Loading Rate	12.6 lb/ft ² -day
4.	Maximum Overflow Rate	156.65 gal/ft ² /day
5.	Center Column Diameter	30 In.
6.	Feedwell Diameter	10 Ft.
7.	Feedwell Depth	5 Ft.
8.	Rake Motor	3/4 HP
9.	Design Running Torque	27,000 Ft-lb.
10.	Momentary Peak Torque	54,000 Ft-lb.
11.	Collector Tip Speed	10 feet/minute

12.	Influent Piping, Primary Sludge	8-In. Diameter, steel
13.	Influent Piping, WAS	6-In. Diameter, steel

2.3 GENERAL

- A. Description: The thickener mechanism shall be of the center drive type, supported on a stationary center column, with primary sludge and WAS entering via an 8-inch and 6-inch diameter pipe, respectively. The thickener shall be designed to remove settled solids from the bottom of the tank.
- B. Materials: All structural steel shall conform to the requirements of ASTM A36. Steel pipe used for structural members shall conform to ASTM A53. Steel members in contact with process liquors, either continuously or intermittently, shall have a minimum thickness of 1/4". All aluminum shall be type 5052, 6061, 6063, or 2014 alloy unless noted.
- C. Fabrication: Shop fabrication of structural members shall be in accordance with the latest edition of the "Structural Welding Code", AWS D1.1, of the American Welding Society. All welded connections shall develop the full strength of the connected elements and all joined or lapped surfaces shall be completely seal welded with a minimum 3/16" fillet weld. Intermittent welding shall not be allowed. All welding shall be done in accordance with the latest edition of the AWS code.
- D. Edge Grinding: Sharp projections of cut or sheared edges of ferrous metals shall be ground to a radius by multiple passes of a power grinder as required to ensure satisfactory paint adherence.
- E. Shop Surface Preparation/Painting: None. All iron and steel surfaces, except the drive unit, shall be field cleaned and painted to ensure paint compatibility and assign unit responsibility for the coating system. The drive unit shall be coated with the supplier's standard enamel paint system.
- F. Structural Design: The ratio of unbraced length to least radius of gyration (slenderness ratio) shall not exceed the values listed in the AISC manual. For angles, the radius of gyration shall be taken about the Z-Z axis. In addition, all structural members and connections shall be designed so that the unit stresses will not exceed AISC allowable stresses when subject to loading of the previously listed peak torque. All steel design shall be in accordance with the AISC Manual of Steel Construction, latest edition, and the International Building Code (IBC), latest edition.

2.4 DRIVE UNIT

- A. Design Parameters: The drive unit shall be supplied by the Manufacturer to ensure unit responsibility. The drive unit shall be designed for the torque values previously listed. It shall turn the mechanism at the designed collector tip speed. The drive main bearing shall be designed for the total rotating mechanism loads with a minimum L 10 life of 50

years, or 450,000 hours. The drive unit shall be capable of producing and withstanding the previously listed momentary peak torque while starting. The drive gear shall be designed to a minimum AGMA 5 rating when rated in accordance with AGMA 2001 B88. The main bearing shall be capable of withstanding the listed overturning moment without the aid of any underwater guides or bearings to ensure correct tooth contact for AGMA rating of the main gear.

All gearing shall be designed per AGMA standard 2001 B88 for strength and surface durability, based on a life of 175,000 hours. The design running torque rating of the drive gearing shall be based on the smaller of the two values determined from the above AGMA standard. To ensure safety and ease of maintenance, all components of the drive shall be direct coupled.

No overhung pinions shall be allowed on the speed reducing unit. The lower pinion bearing shall not be located below the turntable base.

Any and all welding on the drive unit shall be done using E70XX weld rod.

- B. Physical Characteristics: The drive unit shall consist of a solid external main gear, turntable, pinion, secondary speed reducer, support base, and drive unit bearing. The drive shall be mounted on the operating platform frame and support the entire rotating load of the mechanism. The main external gear shall be forged of alloy hardened steel. The pinion shall be heat treated alloy steel. Cast iron housings shall not be allowed. All speed reducers shall be fully enclosed and running in grease. Support base for the drive shall be of welded steel to assure rigidity. Oil and dust shields shall be provided. The drive bearing shall include a forged steel precision gear/bearing set with fully contoured raceways hardened to a minimum 58-60 Rc. Drives using strip liner bearings shall not be allowed. The main gear and pinion shall be grease lubricated. Lubrication fittings shall be readily accessible.
- C. Overload Protection: An overload device shall be provided in a stainless steel, weatherproof enclosure. The device shall be actuated by torque from the rotation of the secondary speed reducer, which shall operate two independently adjustable switches (the alarm switch at 100 percent of design running torque and the motor cutout switch at 120 percent of design running torque). These two switches shall be factory adjusted to accurately calibrate the alarm torque value and the overload position. A visual torque indicator shall be provided and oriented so that it may be read from the walkway. It shall be calibrated from 0 to 160 percent of design running torque.
- D. Turntable: The turntable base shall have an annular bearing raceway upon which the rotating assembly rests. It shall have a maximum allowable deflection in accordance with the bearing specifications. The allowable modulus of elasticity shall be a minimum of 29 x 106 psi. The drive shaft shall be fastened to and supported from the gear hub. Ball bearings shall be of the highest quality high carbon chrome alloy steel running in fully contoured races, as part of a precision gear/bearing set. The balls shall be grease lubricated and protected by elastomer seals.

- E. Speed Reducing Unit: The speed reducing unit shall consist of cycloidal or helical speed reducers directly connected to a motor without the use of chains or v belts, and shall be keyed to the pinion. Worm gear reducers shall not be allowed.

The main ring gear of cycloidal drives shall be made of high carbon chromium bearing steel and be fixed to the drive casing. An eccentric bearing on the high speed shaft shall roll cycloidal discs of the same material around the internal circumference of this main ring gear. The lobes of the cycloid disc shall engage successively with pins in the fixed ring gear. The movement of the cycloid discs shall be transmitted then by pins to the low speed shaft.

Speed reducer helical gearing shall be manufactured to AGMA standards. The speed reducer shall have a service factor of 1.25.

The reducers shall be fitted with radial and thrust bearings of proper size for all mechanism loads and run in a totally submerged oil bath or be grease lubricated.

- F. Motor(s): Motors shall be 1,800 RPM, squirrel cage, induction type, TEFC, ball bearing heavy duty units of ample power for starting and operating the mechanism without overload, with a service factor of 1.15. A motor canopy shall be provided on the rake drive.

Power supply to the equipment shall be 480 volt, 60 hertz, 3 phase.

2.5 WALKWAY AND PLATFORM

- A. Walkway: The 36" wide walkway and platform with handrails shall be supported by the tank wall at its outer ends, and shall be designed to safely withstand a live load of 50 pounds per square foot. Deflection shall not exceed L/360 when the dead load and live load including momentary peak torque are applied. It shall consist of two trusses or beams with 1 1/4" aluminum I-bar grating between the beams. The walkway shall be diagonally braced against lateral movement, and provided with handrails 42" high, of double row 1 1/2" diameter horizontal aluminum pipe, and 4" high extruded aluminum kickplates on both sides. Walkway trusses may serve as hand railings if the top chord is 3' 6" above the walking surface.

Stainless steel bearing plates, UHMW PE slide plates, and anchor bolts for the wall supports, including heavy hex nuts and washers, shall be provided by the equipment supplier and installed by the contractor. Bearing plate dimensions and anchor bolt diameter, length, quantity, and arrangement shall be supplied by the equipment supplier.

- B. Center Drive Platform: A center drive platform shall be provided which allows 24" clearance outside the center drive components. It shall consist of 1/4" aluminum checkered floor plate with necessary stiffeners and supports. The entire platform shall be surrounded by handrails 42" high of double row 1 1/2" diameter horizontal aluminum pipe with 4" high extruded aluminum kickplates.

2.6 INFLUENT AND SOLIDS REMOVAL

- A. Stationary Center Column: A stationary cylindrical steel center column of 1/4" minimum wall thickness shall be provided. One end shall have a support flange for bolting to the tank floor over the influent line, with a similar flange at the top for supporting the drive unit and walkway. The structure and anchor bolts shall provide adequate support for the entire mechanism plus live load and torque with an adequate factor of safety to eliminate excessive deflection or vibration.

Prior to the center column being grouted in place, the drive unit shall be installed, positioned, and leveled.

- B. Influent piping shall be the following:

1. Primary Sludge - 8-inch diameter, Schedule 10 steel
2. WAS - 6-inch diameter, Schedule 10 steel

- C. Feedwell: An energy dissipating feedwell shall be supported outside of the center cage to diffuse the liquid into the tank without disturbance or formation of density currents.

The feedwell shall be made of not less than 3/16" thick steel plate with necessary alignment angles.

- D. Center Cage: The center cage shall be of steel box truss construction. It shall be provided with connections for the rake arms and feedwell supports. The cage top shall be bolted to the main gear which shall rotate the cage with the attached arms and feedwell. The cage and each arm shall be designed to withstand 150 percent of the design running torque of the drive without over stressing the members. Loading to develop the torque shall be considered as uniform loads applied to each arm individually.

- E. Rake Arms: The mechanism shall include two rake arms of steel truss construction with steel scraper blades and adjustable stainless steel squeegees. Squeegees shall be fastened to the rake blades with stainless steel fasteners. The blades shall be properly sized to insure complete raking of the bottom twice per revolution. The blades shall rake the sedimentation to a center hopper. The arms shall be adjustable at the cage to assure an even grout thickness over the tank bottom. Vertical pickets of structural steel angle shall be attached to the rake arms on 2' 0" centers.

2.7 EFFLUENT REMOVAL

- A. Launder: 18" by 18" steel rectangular effluent launders with supports shall be provided for the two (2) existing sludge blending tanks as shown on the Drawings. Steel effluent launders and drop-out box shall be fabricated from 1/4-inch thick steel plate minimum. Provide stiffeners and rods as required. Stiffener angles shall not be located within the launder at areas for conveying effluent. Rods to provide lateral support shall be provided. All bolts, washers, nuts, and shims shall be 304 stainless steel. Provide supports with 304 stainless steel anchors and hardware for epoxy set at tank wall.

Provide felt paper for bond breaker at outside wall of launder as shown on the Drawings. Caulk at locations shown on Drawings and all locations at splices, voids, and other areas where leaks occur.

Provide drop-out box for overflow collection, compatible with launders. Provide ¼-inch neoprene gasket between concrete and drop-out box surfaces. Make watertight. Drop-out box and stiffeners shall be designed by manufacturer, satisfy dead and live load requirements, including buoyancy loads as necessary.

- B. Launder Cover: The overflow launder trough and weirs shall be covered to shield out sunlight. The cover supports shall be anchored off the tank wall. The covers shall be hinged to provide easy access for overflow trough inspection. The troughs shall be capable of supporting a 250 lb man load. The covers shall be fabricated from fiberglass.

1. UV-treated fiberglass resin.
2. Glass content: 30 percent minimum by weight.
3. Surface: Smooth with no exposed glass fibers, resin rich to prevent migration of moisture.
4. Molded fiberglass brackets and stiffeners.
5. Laminations: Free of voids, dry spots, cracks, and crazes.
6. Color: White.
7. Fasteners: 316 stainless steel; fender washers, lock washers, and hex nuts for bolted or threaded connections.

- C. Weir: An adjustable weir shall be provided around the periphery of the tank at the water surface for removal of clarified overflow.

The weir shall consist of ¼-inch thick x 10½-inch deep aluminum sections with 2½-inch deep 90 degree v-notches at 6-inch intervals. The weir sections shall be curved and fastened to the launder wall with special large washers, anchor bolts, and hex nuts to allow 2½-inch minimum vertical adjustment. All weir hardware including washers, anchor bolts, nuts, fasteners, etc. shall be Type 304 stainless steel. Provide ¼-inch thick neoprene gasket.

2.8 CONTROL PANEL

- A. Provide NEMA 4X stainless steel control panels for start, stop, and alarm functions for Pre-Thickener Nos. 1 and 2 drive units. The control panels shall include pushbuttons, running lights, fail safe relays, red alarm light, horn, silencer button and interlock reset buttons. A lockable fused circuit breaker, overload relays, motor starters, 20 amp GFI receptacle transformer, and space heater (25 watt minimum) shall also be provided.

- B. Provide contactor for digital signal for remote monitor of run and fault (over torque) conditions.
- C. Provide contacts for audible alarm box and alarm light by contractor.
- D. Provide transformer for 120 volt control power and over torque switch.

2.9 ANCHORAGE AND FASTENERS

- A. Anchor Bolts: All anchor bolts shall be a minimum of 1/2" diameter and made of type 304 stainless steel. The equipment supplier shall furnish all anchor bolts, nuts, and washers required for the equipment.
- B. Fasteners: All structural fasteners shall be a minimum of 1/2" diameter and made of type of type 304 stainless steel. The equipment supplier shall furnish all fasteners required for the assembly of the equipment.

2.10 SPARE PARTS

- A. The following spare parts will be provided.
 - 1. One complete set of all bearing seals
 - 2. One complete set of stainless steel squeegees
 - 3. One oil dip stick or sight glass

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: The equipment shall be installed properly to provide a complete working system. Installation shall follow the supplier's recommendations.
- B. Shop Assembly: The equipment specified herein shall be completely factory assembled as one unit as far as practical. All mating parts shall be trial fit and match marked. The manufacturer shall submit certification of shop assembly before shipment.
- C. Field Service: The equipment supplier shall provide the service of a qualified representative for two (2) trips and four (4) days to inspect the mechanism installation, assist in start up, and instruct plant personnel in the proper operation and maintenance of the mechanism.
- D. Field Testing:
 - 1. Torque Tests: The entire sludge collector mechanism shall be statically load tested by individually loading each rake arm with 150 percent of the specified design running torque. The test shall verify the torque overload control device

settings for alarm and motor cutout. Each arm shall be individually anchored and the load measured to demonstrate the rake arms', cage's, and drive unit's ability to withstand the specified torque. Sketches and calculations shall be submitted illustrating how the torque will be applied prior to the test taking place.

2. Operation Tests: The mechanism shall be operated in a dry tank for a minimum of 4 continuous hours before flow is allowed to enter the system. There shall be no binding, jerky, or unusual motion exhibited during this run in period. Motor amperage shall be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 4 hour observation test run. If the unit should fail under any of these conditions, the test shall be halted and the problem corrected. If, after several attempts, the unit does not successfully pass the field test, the faulty portion of the equipment shall be replaced and the test re run.

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WASTE GAS BURNER REPLACEMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section covers all equipment, materials, accessories, and labor required to assemble, install, test, and place into satisfactory service a complete waste gas burner with automatic pilot ignition, flame monitoring, pressure regulator and flame trap assembly, and other appurtenances as specified herein and shown on the Drawings.

1.3 QUALITY ASSURANCE

A. GENERAL

- 1. The Contractor shall be responsible for ensuring that all equipment installed is properly connected to other related equipment for proper functioning of the Plant.

B. WARRANTY

- 1. The Contractor shall provide from the equipment Manufacturer an extended warranty for a period of 12 months after acceptance of equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event that the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

C. MANUFACTURER'S QUALIFICATIONS

- 1. Equipment and materials provided under this Section shall be the standard product in regular production by Manufacturers who shall have at least five years experience in the design and fabrication of the equipment as described herein, used for similar applications and shall have at least five installations of similar size and type within the last 5 years.

1.4 EQUIPMENT IDENTIFICATION

- A. Equipment covered in this Specification is identified as follows:
 - 1. Waste Gas Burner

1.5 SUBMITTALS

- A. Submit complete shop drawings and engineering data to the Engineer in accordance with the requirements of the General and Supplementary Conditions, including the following:
 - 1. Manufacturer's literature, illustrations, specifications, and engineering data including description of operation and controls, connection details, and performance data.
 - 2. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.

1.6 STORAGE AND PROTECTION

- A. Store and protect the waster gas burner equipment and accessories in accordance with the requirements of Division 01.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The design has been based on equipment provided by the following manufacturers:
 - 1. Groth Model 8391B
 - 2. Varec, Model 244WL Series
 - 3. Or approved equal

2.2 SYSTEM PERFORMANCE

- A. Design Parameters
 - 1. Waste gas: digester gas
 - 2. Burner capacity: 21,000 CFH min. @ ½-inch W.C.
 - 3. Pilot gas supply: natural gas
 - 4. Pilot gas supply line size: ½-inch diameter NPT

2.3 SYSTEM COMPONENTS

- A. WASTE GAS BURNER
 - 1. The 8-inch waste gas burner shall consist of an automatic ignition system and flame monitoring equipment, electrical controls and starters, and all appurtenances required for the complete burning of excess digester gas generated from the two anaerobic digesters.

2. The waste gas burner construction shall consist of all stainless steel components in the flame area, carbon steel burner pipe and flanged stainless steel inspirating venturi.
3. Windshield shall include a bevel designed outlet to prevent downdraft and flame licking.
4. Burner nozzle to include vortex vanes to insure digester gas/air mixture.
5. Burner to be self supporting on 150# ANSI flange for winds to 150 mph and shall meet Seismic Zone 4 requirements

B. FLAME TRAP ASSEMBLY

1. Assembly shall include thermal shut-off valve and flame arrester. Unit shall be suitable for installing in the horizontal or vertical position.
2. Thermal valve shall include a fusible element designed to close the valve within 15 seconds upon reaching 260°F.
3. Fusible element shall control a spring-operated pallet. An isolated sight glass shall be provided so that pallet position can be determined without having to remove the valve from service. Fuse plug shall be gas tight and shall be removed for replacement of the fusible element.
4. Valve construction shall be low copper cast aluminum body and cover. Inner valve shall include low copper aluminum pallet assembly with 304 stainless steel compression spring. Sightglass shall be acrylic with neoprene gaskets.
5. Flame arrester net free area through the bank assembly shall be not less than three times the corresponding size standard pipe. Entire bank assembly shall slide easily out of the arrester housing to facilitate inspection and cleaning. Removing or replacing the bank assembly shall not require support for alignment, jackscrew for extending the housing, and shall not place a strain on the connecting piping. Bank frame shall be extensible and shall be filled with corrugated rectangular shaped bank sheets. Frame arrester shall include an offset housing with a 1/2-inch NPT connection to allow condensate draining when installed in the horizontal position.
6. Arrester housing construction shall be low copper cast aluminum. Bank assembly shall include a low copper aluminum frame and stainless steel sheets.
7. Flanges shall be drilled to ANSI 150# flanged dimensions.
8. Thermal shut-off and flame arrester shall be factory assembled as one unit.

C. FLAME CHECK

1. Flame check shall have 1/2-inch (regulator vent line) and 2-inch NPT connection and shall be installed on the pilot gas supply line. Housing shall be of "pipe

union" design to permit easy disassembly for inspection and cleaning. Element shall be replaceable and made of compressed 316 stainless steel woven wire. Housing shall be constructed of low copper cast aluminum. Maximum working pressure shall be 25 psig (172 kPa).

D. AUTOMATIC PILOT IGNITION CONTROL PANEL

1. The automatic pilot ignition control panel shall be housed in a NEMA 4X 316 stainless steel enclosure and shall provide automatic pilot ignition upon receiving signal (closed contact) from a pressure switch.
2. Pilot controls shall provide sparking for a predetermined time or until the pilot is lit and will provide an alarm contact for "Flame Failure" if ignition is not realized within the adjustable time limit.
3. The "Flame Failure" alarm shall operate anytime a flame is not sensed while the system is in the operate mode. A reset switch shall be provided to reset the control system.
4. A switch shall be provided on the control panel for manual mode and will override the automatic mode.
5. A status contact for "Pilot On" shall also be provided at the control panel. Status lights shall be provided for "T/C Monitor OK", "Pilot Gas On", "Pilot Flame On", and "Pilot Flame Failure".
6. The control panel shall include all necessary pilot controls to provide automatic "startup", flame sensing, re-ignition sequence for flame failure and automatic "shut-down" on "contact-open" signal. A solenoid valve shall be provided to operate the pilot fuel on/off function.
7. The pilot system shall provide a stoichiometric air/fuel mixture by utilizing an inspirating venturi and shall sense the pilot flame by use of a thermocouple.
8. The maximum pilot fuel consumption shall be 45,000 BTU/hr.
9. Electrical input of the control panel shall be 120 V, single phase, 60 Hz, 10 Amps, grounded neutral.
10. Contacts for remote monitoring shall be "Flame-On", normally open, 5 amps at 120 VAC, and "Flame-Failure", normally closed, 5 amps at 120 VAC.
11. Minimum pilot fuel input shall be 4" W.C. to 10 psig supply pressure. No blower assistance shall be allowed for supply pressures from 9 inches W.C. to 10 psig.
12. Pressure switch shall be explosion proof and have an operating range of 4" to 20" W.C. with a 0.4" to 0.6" W.C. dead band.

2.4 FINISHES

A. GENERAL

1. Provide Manufacturer's standard shop applied coating suitable for the service indicated.
2. Anchors, protective coating, and painting shall be in accordance with the Manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install equipment in accordance with Manufacturer's recommendations.

B. Touch-up Coating

1. Touch up all damaged coating surfaces with compatible coating of identical color in such manner that there shall be no evidence of damage.

3.2 START-UP AND OPERATION

A. START-UP SERVICES

1. The manufacturer shall furnish the services of a factory-trained field engineer specializing in this work to inspect and adjust the equipment after installation, to test the equipment, to supervise start-up, and to instruct the Owner's personnel in its proper use. Provide a minimum of one day of operator training for both operation and routine maintenance requirements.

B. FIELD TESTS

1. Test the unit under actual operating conditions to show that the equipment operates satisfactorily.
2. Allow Engineer to observe field tests. Give ten days' written notice to Engineer before performing tests.
3. Test system operation with control scheme specified or shown on the Drawings.
