SECTION 28 48 00 - EMERGENCY RESPONDER RADIO SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Provide, install, test, document and register a complete and fully operational Emergency Responder Radio System as specified, including, but not limited to, a bi-directional amplifier, donor antenna and mounting structure, lightning protection, passive distribution devices, distribution antennas, cables, connectors and all other Materials and Equipment required to fulfill the performance criteria as indicated herein, and be fully compliant with the requirements outlined in all applicable codes. Note, the specification is a performance based specification for a turn-key installation. It shall be the responsibility of the successful bidder to provide turn-key services that shall include, but not be limited to:

1. Verify and document the required frequency(ies) to be re-broadcast with any/all Emergency Responders within this area of jurisdiction,
2. Determine and document the location(s) of the appropriate donor tower/repeater,
3. Ascertain and document through measurement using a calibrated spectrum analyzer the available signal from the aforementioned donor(s) at the best available location on the facility roof,
4. Create a design that shall provide performance as prescribed herein, optimizing available signal while maximizing signal isolation of the donor from the interior distribution,
5. Provide any/all required donor antenna(s) and mounting structure(s),
6. Coordinate the installation of a pre-fabricated roof penetration that shall maintain the warranty and capabilities of the roof structure,
7. Coordinate a service-able location for the lightening protection and properly bond same to a reliable grounding plane,
8. Determine and coordinate the use of the best available location for the bi-directional amplifier,
9. Coordinate the bi-directional amplifier location and required related services such as power,
10. Provide code required backup power source and requisite interconnections,
11. Develop and implement the distribution of the signal throughout the entire interior of the new facility,
12. Provide, locate and interconnect code required alarm points and means of annunciation,
13. Provide and facilitate testing and sign off by the Authority Having Jurisdiction and any/all Emergency Responders requiring the use of the system,
14. Complete any/all required registration submissions to the FCC and/or other governing or managing entity.

B. The required system shall provision all applicable frequencies for Ohio MARCS coverage.

1.02 SECTION INCLUDES

A. Section Includes:

1. Bi-Directional Amplifiers

2. Backup Power Source
3. Donor Antenna
4. Antenna Mounting Structure
5. Lightening Protection
6. Coaxial Cabling
7. Passive Distribution Devices
8. Distribution Antennas
9. Alarm Panel Interface and Annunciation

1.03 RELATED SECTIONS

A. Section 27 05 00: Common Work Results

B. Section 27 05 24: Fire Stopping

1.04 REGULATIONS

A. Codes, regulations and standards referenced in the Section are:
1. NFPA 1 – The National Fire Code
2. NFPA 70 – The National Electrical Code
3. NFPA 72 – The National Fire Alarm Code
4. FCC 47 CFR Private Land Mobile Radio
5. IFC – The International Fire Code

1.05 DEFINITIONS

A. Definitions:
1. Bi-Directional Amplifier BDA: Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station for enhanced signals and improved coverage.
2. Emergency Responder Radio Coverage System: A two-way radio communication system installed to assure the effective operation of radio communications systems for fire, emergency medical services or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.
3. Delivered Audio Quality Definitions (DAQ): This is a universal standard cited in system designs and specifications.
   a. DAQ 1: Unusable, speech present but unreadable.
   b. DAQ 2: Understandable with considerable effort. Frequent repetition due to noise/distortion.
   c. DAQ 3: Speech understandable with slight effort. Occasional repetition required due to noise/distortion.
   d. DAQ 3.5: Speech understandable with repetition only rarely required. Some noise/distortion
   e. DAQ 4: Speech easily understood. Occasional noise/distortion.
   f. DAQ 4.5: Speech easily understood. Infrequent noise/distortion. \
   g. DAQ 5: Speech easily understood.

h. Coupled Bonding Conductor (CBC): a bonding conductor placed, e.g. strapped, on the outside of any technology cable, used to suppress transient noise.
i. FCC: Federal Communications Commission
j. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
k. Public Safety/First Responder: Public Safety or First Responder agencies which are charged with the responsibility of responding to emergency situations. These include, but are not limited to: law enforcement departments, fire departments, and emergency medical companies.

1.06 GENERAL

A. The completed systems are required to pass proof-of-performance tests as described and specified.

B. The system shall remain on line regardless of power abnormality or failure for a minimum of 4 hours without disruption or need to cycle power, or reset the system.

C. All antenna cabling routed from an exterior antenna to an interior point of distribution shall have lightning protection with performance specified for the frequency(ies) of expected operation, as well as the capability to pass DC as may be required for antenna detection for the alarming features of the amplifier and system.

D. All equipment shall be UL listed and labeled, and accordance with applicable NEMA and ANSI Standards.

1.07 SUBMITTALS

A. Submit a list of 5 representative projects as described in the Quality Assurance paragraphs below.

B. Submit a copy of any/all FCC licensing held by the Contractor and/or Project Manager.

C. Prior to installation, submit to the Engineer for review and approval all calculations and measurements relative to available signal strength at donor antenna location, expected cable lengths, passive device sizing, antenna locations and expected output based on available signal at donor, amplification and link loss.

D. Submit in accordance with Section 27 05 00, a detailed riser showing the actual installation values of the passive devices, cable lengths and amplifier calibration as a function of the as-built documentation.

E. The Contractor shall submit to the Owner as a condition of final payment and acceptance, the following documentation:
1. A single reproducible set of drawings of the system, exactly as it was installed with all cable numbers designated on the drawings.
2. Three copies of the test results for the system installed. The test results shall be presented in a printed or typed format in soft cover binders.

3. Contractor shall provide electronic files of the Record Drawing information to the Owner in the Operations and Maintenance Manuals.

1.08 QUALITY ASSURANCE

A. Contractor Requirements:
1. All work shall be performed by a qualified radio system contractor holding a valid Contractor's license of a class for the work to be performed.
2. The Contractor shall be an authorized reseller and service agent of the equipment manufacturer for the equipment being provided.
3. The Contractor's crew shall be comprised of personnel that are factory trained in the installation and service of the equipment being provided.
4. Contractor shall have documented experience of having supplied similar systems of like size and complexity for a minimum 5 years. Upon request, the Contractor shall supply a minimum of five references that shall be checked by the Owner. The references include the name of the organization for which the installation was provided, the address of the specific location of the installation being referenced, the name and phone number of a current point of contact, as well as the point of contact at the time of installation, and a description of the system provided
5. The Contractor shall maintain a local sales and service depot which contains current spare parts stock specifically related to the major system components being provided, as well as test equipment and service vehicles. The aforementioned depot shall be located within a 50 miles radius of the project site with a maximum travel time barring unusual conditions of no greater than 60 minutes.

B. All wiring enclosures, terminal cabinets, outlets, control boxes, frames of cabinet racks, and other enclosures shall be grounded in compliance with the requirements of the National Electrical Code.

1.09 PERFORMANCE

A. Signal Strength
1. Downlink: A minimum signal strength of -95dB shall be provided throughout the coverage area, and a minimum of DAQ 3.0 for either analog or digital signals. The coverage area shall be the entirety of the facility, and shall not be limited to only the area of construction and remodel.
2. Uplink: A minimum signal strength of -100dBm shall be received at the local First Responder Radio System from the coverage area, and sufficient enough to provide a minimum of DAQ 3.0 for either analog or digital signals.

B. Contractor shall verify signal strength with local authorities having jurisdiction at the completion of the building envelope (walls, doors, windows, etc) and prior to the installation of the ceiling grid, per the above requirements and all local requirements.

C. Donor antennas shall maintain a minimum of 20 dB above the interior signal strength under all operating conditions.

D. Frequency(ies) required shall be coordinated with any/all required First Respondents assigned to this jurisdiction. The Contractor shall obtain a written listing of all applicable

frequencies and licensees of same, verify the frequencies with the licensees, and adapt as required.

E. Output Level Controls: Automatic Level Control and Automatic Gain Controls shall be included to prevent performance that could either damage and/or inhibit the operation of the system, or its effect on other systems.

F. The system shall be capable of processing and propagating both analog and digital communications signals simultaneously at the time of installation.

G. All components, component enclosures and RF emitting devices shall have the certification of the radio licensing authority prior to installation and be compatible with both analog and digital communications, and compatible with any/all required modulations schemes as required by any/all First Responders assigned to this jurisdiction.

H. The system provided shall be compatible with the radio systems associated with the City of Warrensville Fire Department (WFD). WFD utilizes xxxxxxxxxxx which deploys radio equipment licensed for both xxxPS and xxxPS radio bands. All Devices, equipment and materials shall be designed specifically to be utilized across the entirety of the xxxPS and xxxPS bands with no exceptions. Upon completion, WFD shall be the entity from whom signed approval shall come. Coordinate all testing and validation with the WFD. Provide any required filtering or other ancillary devices to properly guard interference by or to cellular service while assuring proper operation of the in-building system. Furnish and submit all required registration paperwork to the FCC or other authorities as may be required.

1.10 POWER SUPPLY

A. The system shall utilize two independent and reliable power supplies, and shall be provided for all equipment required to keep the entire system on-line and operational, one system shall be considered as primary, the other as secondary or backup.

B. The primary power source shall be by means of a dedicate branch circuit and comply fully with NFPA 72.

C. The secondary power source shall be storage battery dedicated to the system with the ability to operate the system for 12 hours at 100% capacity.

1.11 SYSTEM MONITORING

A. The system shall provide monitoring points to assure operational integrity of power supplies and system operation that shall both tie to the fire alarm system, and provide local dedicated annunciation at a location approved by the local authority having jurisdiction.

B. The communications link between the fire alarm system and the Public Safety Radio Reader System shall be monitored for integrity.

C. The monitoring points shall be supervisory points and shall be for
1. Donor Antenna malfunction

2. Active RF emitting device failure
3. Low Battery Capacity indication when 70% of the 12 hour operating capacity has been depleted
4. System component failure
5. Normal AC Power Failure
6. Battery charger failure

D. A dedicated monitoring panel shall be provided within the fire command center or other location as required by the local authority having jurisdiction. The monitoring panel shall annunciate the ongoing status of all points indicated above and provide an alpha based readout of same. The communications link between this system and the Public Safety Radio Repeater System shall be monitored for integrity.

1.12 WARRANTY

A. The Contractor shall provide a warranty for all equipment, labor, installation and calibration to be free from defects in materials and workmanship for a period of two (2) years after system is installed and accepted.

B. Warranty shall be enforced twenty four hours a day seven days a week (24x7x365) with an onsite response time no greater than four (4) hours.

C. Personnel enforcing the warranty shall be factory authorized agent for said warranty.

D. The Warranty shall include a retesting and as may be required recalibration in a window of no less than 30 and no more than 60 days from the time of Owner acceptance.

E. In addition to the warranty prescribed herein, the successful bidder shall also include in their bid submission a maintenance contract that shall have options for both a one year contract and a three year contract. Said contracts shall commence from the first day after the expiration date of the warranty without lapse, and shall include all materials and labor required to continue ongoing coverage of the system as if under the original warranty, i.e. parts and labor, as well as any recalibration that may be required due to component aging or other normal wear and tear factors.

PART 2 - PRODUCTS

2.01 EQUIPMENT STANDARDS

A. Where applicable all equipment installed under this contract shall be new and listed by UL.

2.02 EQUIPMENT

A. Bi-directional Amplifiers (BDAs)
1. The BDAs shall be integrated push pull circuitry housed in a heavy die cast 100% shielded enclosure.
2. The BDAs shall be equipped with local visual alarms.
3. The BDAs shall have a low noise figure and wide dynamic range.

4. The BDAs shall have mounting tabs for securing to any flat surface.
5. The BDA's shall be designed specifically for the application for which it is intended, i.e. the BDA associated with that of public safety coverage shall be specifically designed for bi-directional amplification of public safety radio communications, etc., as well as code compliant where required, e.g. the public safety BDA shall be complaint with the International Fire Code (IFC) and NFPA standards and shall be in a NEMA 4 or 4X rated.
6. The BDA upper and lower band pass frequencies shall be as required by the frequencies of the assigned First Responder(s) Radio System plus a guard band both above and below the passband to prevent interference between this system and others operating in close proximity and adjacent channels.
7. The BDAs shall meet or exceed the following performance specifications:
   a. Gain (Min Attenuation): 60dB
   b. Gain Flatness: ± 1.5 dB (Max)
   c. Noise Figure: 3.5 dB (Max)
   d. Gain Adjustment: 0-30 dB(min) in 2 dB steps (max)
   e. Power Output @1dB Compression
      1) Uplink: +32.0 dBm (Typ)
      2) Downlink: +40.0 dBm (Typ)
   f. Output Power ALC Set
      1) Uplink: +25 dBm ± 1
      2) Downlink: +33 dBm ± 1
   g. Output Composite Power
      1) Uplink: +25 dBm (Typ)
      2) Downlink: +33 dBm (Typ)
   h. 3rd Order Output Intercept Power
      1) Uplink: +46 dBm (Typ) @ 2Tones + 22 dBm each
      2) Downlink: +56 dBm (Typ) @ 2Tones + 30 dBm each
   i. Input Impedance: 50 Ω
   j. VSWR In/Out: <1.5:1
   k. Propagation Delay: <1µS
   l. Power Supply: 110VAC-220VAC Autoranging 50 – 60 Hz
   m. Operating Temperature: -20° C. to +50° C.
   n. Acceptable Manufacturers shall be:
      1) Byrd/TXRX, Cellular Specialties, GWave, Honeywell Notifier

B. Backup Power Enclosure
1. The backup power enclosure shall be a designed assembly that shall either wall mount using mounting tabs permanently affixed to the tops and bottom edges of the assembly, or floor mounted with legs to lift the enclosure up from the floor of the space within which it is housed.
2. The backup power enclosure shall be sized to house the batteries required, plus have clearance above to mount a DIN rail for the power monitoring and regulation devices and terminal strips.
3. The backup power enclosure shall be NEMA 4 or 4X rated.
4. The backup power enclosure shall include DIN rail mounted terminal strips for all cable terminations. Such DIN rail terminal strips shall be for 100% of the terminations of the equipment within, other than the actual battery terminal connections.

5. All terminations within the enclosure shall be labeled with machine generated labels made from material that shall maintain the printing throughout the life of the enclosure.
6. Any connections made either to the enclosure, or to devices within the enclosure requiring replacement due to periodic standard maintenance shall be connectorized so as to allow quick easy installation and removal.

C. Donor Antenna(s) Mounting Structure
1. The mounting structure shall be a pre-fabricated exterior grade assembly, that shall be hot-dip galvanized, and non-penetrating.
2. The mounting structure shall be a ballast type mount having a rectilinear base assembly that is designed to hold concrete cinder blocks as ballast.
3. The mounting structure shall include a rubberized non-slip pitch pad below to help prevent damage to the roof treatment.
4. Include an appropriately high mast extension to prevent shadowing by the structure or equipment mounted on top of the structure.
5. Acceptable manufacturer shall be:
   a. Rohn, Baird or Solid Signal

D. Isolation Directional Couplers and Taps:
1. All taps shall be of the directional coupler design. The specified directional couplers and taps shall be N-type or as indicated on the Drawings.
2. All taps and couplers shall have minimum power capacity of 30W.
3. All taps and couplers shall have a minimum usable frequency range as dictated by the band utilized by the assigned First Responder
4. Acceptable Manufacturers
   a. Byrd, Cellular Specialties, GWave

E. Combiners/Splitters:
1. Splitters shall be two way and three way and N-type or as indicated on the Drawings.
2. Splitters shall a minimum of 10W power handling capacity.
3. Splitters shall have a minimum usable frequency range as dictated by the band utilized by the assigned First Responder.
4. Acceptable Manufacturer
   a. Byrd, Cellular Specialties, GWave

F. Lightning Protection (LP)
1. LP shall have a frequency range that shall be a minimum of the passband of the BDA.
2. LP shall have a VSWR of <1.1:1
3. LP shall have an insertion loss of <0.1dB.
4. LP shall have a maximum surge current of 10kA
5. LP connectors shall be N-type.
6. Acceptable manufacturer:
   a. Polyphaser, l-com or Times Microwave

G. Antennae, Donor
1. Donor antennas shall be directional.
2. Donor antennas shall be designed for the passband required as defined above.

3. Donor antenna shall have an adjustable gamma to tune the antenna for minimum VSWR at a frequency at the middle of the passband.
4. Antenna connectors shall be N-type.
5. Acceptable manufacturer and series:
   a. Comprod, Laird or Byrd

H. Cable
1. Distribution, ½" cable
   a. The cable shall be a ½" air dielectric corrugated construction with an inner conductor of copper clad aluminum and an annularly corrugated copper outer conductor covered in a flame retardant plenum rated blue sheath.
   b. The cable shall have a resistance of no more than 0.45Ω/ft on the inner conductor, and no more than 0.58Ω/ft on the outer conductor.
   c. The cable shall have a characteristic impedance of 50Ω.
   d. The cable shall have a minimum bending radius of 5 inches.
   e. Acceptable Manufacturer and Model shall be:
      1) RFS, Times Microwave or Commscope
2. Drop, .400 cable
   a. The cable shall be a .400" construction with an inner conductor of copper, a dielectric of low density PTFE, an outer conductor of aluminum tape, an overall braid of tinned copper and an FRPVC flame retardant plenum rated orange sheath.
   b. The cable shall have a resistance of no more than 1.8Ω/1000ft on the inner conductor, and no more than 1.65Ω/1000ft on the outer conductor.
   c. The cable shall have a characteristic impedance of 50Ω.
   d. The cable shall have a minimum bending radius of 4 inches.
   e. Acceptable Manufacturer and Model shall be:
      1) Times Microwave, RFS or Commscope
3. Coaxial Connectors
   a. Provide coaxial connectors that are designed for use with the required cabling and which provide continuous maximum radiation security, which exceeds FCC requirements for radiation suppression.
   b. All connectors shall be a type "N" connector, unless specifically required to be otherwise.
   c. All connectors shall utilize solder for the inner contact attachment method, and crimp for the outer contact attachment method.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Utilize directional couplers or splitters so as to provide a uniform distribution to all distribution antennas such that the deviation between the signal output of any two antennas is no greater than 3 dB. Simple signal splits without the care of this requirement shall not be acceptable and shall be required to be re-worked at no additional cost to the Owner. Upon testing of system performance, where may be required, relocate and/or add antennas and rebalance system so as to meet this requirement.

B. Locate antennas so as to minimize and equalize the signal deviation between any/all pairs of antennas to assure even signal distribution across the coverage area.

C. Route all cabling, back filling any opening requiring fire stopping, or other sealant as required to either maintain the fire rating of the barrier or maintain the seal of the barrier from outside contaminants.

D. Provide lightning protection for each antenna cable run back into the building at the earliest practical point of entry and ground the lightening protection to the approved grounding busbar.

E. Install and calibrate as necessary any/all devices.

F. Install roof penetration pitch pocket under the supervision and approval of the roofing contractor to facilitate continuation of any/all roof warranties.

G. For cable routed across the roof, provide periodic support devices that shall be non-penetrating and have a rubberized surface on the bottom to protect the roof surface, and have a means by which to attach the cable to maintain spacing no greater than every three feet or as recommended by the cable manufacturer, whichever is less.

H. All coaxial cable runs shall be continuous between devices. No connectors, fittings, terminations, splices or passive devices shall be installed in any inaccessible location. Said connections shall only be made at outlets, junction- boxes or terminal cabinets or as noted on Drawings.

I. Properly identify all cabling with machine generated labeling. Verify with the Engineer and Owner the proper labeling schema.

J. Tag and identify all passive devices, including, but not limited to all passive devices mounted within the ceiling spaces throughout the building. Label the ceiling frame directly below the location of any device mounted in the ceiling spaces. Coordinate the labeling scheme, and font details with Owner prior to labeling.

K. Where splitters and couplers are mounted in terminal cabinets they shall be mounted using L-brackets with cable connections made in a vertical plane.

L. Install the backup power source and after sufficient charging time verify operation of the backup power source under load.

M. All coaxial cables used for interconnection in terminal cabinets shall be tagged and neatly dressed to facilitate servicing and identification.

N. All coaxial connectors shall be installed using factory recommended tools designed for the connectors being installed.

O. All equipment shall be mounted securely by means of mechanical attachment at a minimum of four points of attachment. Cables shall not be run horizontally for more than nine inches without being secured. Cables and cords to panel mounted equipment shall all enter from the same side to allow the panel to be swung out for access and service.

P. All donor and distribution cable shall be routed utilizing sweeping bends of no less than 10 times the radius of the cable.

Q. All cabling shall be routed straight and smooth with no kinks or other deformations of the cable. Should any segment become kinked or otherwise deformed such that a performance degradation is possible, the Contractor shall replace that entire segment of cable.

R. Document the results of all coverage testing and include them in the Operations and Maintenance Manuals. Verify coverage, after initial testing and verification of system performance, with any/all First Responders assigned to this jurisdiction. Collect sign off on performance verification with each of these First Responders. Retain a copy on file for the Contractor reference. And, turn the original over to the Owner for their records.

S. Register the system with the FCC and any other local frequency coordinator as may be required.

3.02 TESTING - DOCUMENTATION - PROOF OF PERFORMANCE

A. Prior to proof of performance, the Contractor shall test the entire coverage area utilizing the 50 foot grid method. Grids shall be segmented to each of the major building sections as indicated on the Drawings.
   1. For testing system signal strength and quality, the testing shall be based on the delivered audio quality (DAQ) system. A DAQ level below 3.0 shall be considered a failed test for a given grid cell.
   2. Measurements shall be made with the antenna held at 3 to 4 feet above the floor to simulate a typical portable radio work on the belt or turnout coat pocket, including but not limited to circumstances where the orientation of the antenna is perpendicular to the expected polarization of the source.

B. Verify proper performance, adjust and correct the performance as necessary. Once this has reached an acceptable outcome, perform the proof of performance for the Owner and the First Responder assigned to this jurisdiction.

C. Before the Contract is considered complete, the Contractor shall demonstrate the performance of the system in the presence to the Engineer, Owner and any/all First Responders assigned to this jurisdiction at no cost to the aforementioned parties. Provide small scale drawings no larger than 11x17 to all parties witnessing the proof of performance testing. The plans shall be divided into the grid utilized for the testing and shall have clearly marked in each grid section the DAQ and signal strength measurements collected during the contractor's system testing. Include in the proof of performance demonstration and proof of performance of the amplifier and the alarm monitoring points both at the fire alarm system and the local annunciator. The First Responder(s) shall be the final judge as to the acceptability/accuracy of the documented DAQ.

D. The Engineer or Owner may order any changes, adjustments, or further tests deemed necessary to assure that the systems are complete and operational in accordance with the Specifications. Said changes and/or modifications shall be completed in a timely fashion and at no additional cost to the Owner, unless such changes are above and beyond that required to make the system perform to the acceptance of the First Responders assigned to this jurisdiction.

E. The Contractor shall provide all test and reception gear required to prove the performance as outlined and all costs of test and documentation will be borne by the Contractor.

F. The Contractor shall provide as built documents in the latest revision of AutoCAD in both electronic and hard copies at full size in the O&M Manual. Provide one additional copy of the as-built documents at the location of the head end equipment.

G. Correction of Defects: If the Owner or Engineer deems that the system or any part of the system does not meet the specified performance, the Contractor shall conduct further tests including complete sweep analysis to locate faulty or defective components or faulty workmanship. The Contractor shall replace any defective components, parts or cables before further tests are ordered.

END OF SECTION