(This is a design guideline spec. It's the responsibility of the Design/Installation team to develop project specific specifications to meet the project requirements.)

SECTION 275319

EMERGENCY RESPONDER RADIO COMMUNICATION SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Radio distribution system to support Emergency Responder Radio Communication System, Emergency Communications Systems, and multiple first responder Radio Systems for Emergency Response wireless services, primarily in-building – herein "System".

B. Base Bid Work

1. The work of this section includes furnishing materials, installation, and coordination through the General Contractor with other trades for a complete, operational, and balanced Emergency Responder Radio Communication System. Provide a complete turn-key system that supports frequencies and services throughout the coverage spaces specified herein. Furnish materials, accessories, fasteners, etc., and the labor and associated services necessary for a complete and operational System, whether expressly stated or not. Coordinate the work of this section with other trades through the General Contractor.

2. The work of this section includes the following:
   a. Provide Project management services
   b. Validate current and planned future emergency services and associated frequencies
   c. Coordinate antenna placement and mounting coordination with the General Contractor and affected trades; mounting confirmation with both the architect and the Owner
   d. Conduct initial on-site discovery survey
   e. Provided detailed system design and drawings
   f. Review of pathways and enclosures for NFPA 1221 compliance
   g. Provide coordination with the overall construction team and usage of provided pathways
   h. Provide installation and system balancing
   i. Provide coordination with the overall construction team and usage of pathways provided by others
   j. Provide NEMA 4-type waterproof cabinet
   k. Include patch cords (to connect System equipment)
   l. Manage FCC licensing and FCC registration, including Part 90 requirements
   m. Provide system acceptance testing and turn over to Owner
   n. Provide a warranty
   o. Provide maintenance and support services

3. Power Service:
   a. Coordinate with the electrical contractor the power provisions required for the System. The ERRCS contractor is solely responsible to ensure proper electrical power service.

b. Provide power backup battery to support the System with a runtime of 12 hours, minimum. If the project includes a standby power source (e.g., a generator) that provides backup power for at least 12 hours, then provide backup battery with a runtime of 10 minutes, minimum. If the project does not include a standby power source, then provide power backup battery with a runtime of 12 hours, minimum

4. Coordination Requirements:
   a. Ceiling Types: Understand every ceiling type and its interaction with the System. For example, some ceiling types may impede RF signals and, subsequently, performance.
   b. Mounting Details: Coordinate antenna mounting and the resulting RF performance. It may be preferred that antennas be mounted above or below ceiling grid. Coordinate with both the architect and the Owner. Adjust as approved to optimize performance.
   c. Pathways: Coordinate placement of System cables within pathways provided by others. Only place System cables into pathways provided by others with their permission.

C. Work Covered Under Other Sections
   1. Electrical power – raceways, junction boxes, circuits, branch wiring, and receptacles
   2. Pathways – backbone conduits, primary pathways (such as cable trays), conduits, sleeves
   3. Telecommunications Rooms – equipment support (racks/frames), power service, cooling, and grounding

D. Related Sections
   1. Comply with the Related Sections requirements of the following:
      a. Div 01
      b. Div 26
      c. Section 270000 Communications
      d. Section 270526 Grounding and Bonding for Communications Systems
      e. Section 270528 Interior Pathways for Communications Systems
      f. Section 270543 Exterior Pathway for Communications Systems
      g. Section 270553 Identification for Communications Systems
      h. Section 283100 Fire Detection and Alarms System

1.02 REFERENCES

A. Comply with the References requirements of related sections (above).

B. In addition to the codes and standards listed in section 270000, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
   1. Committee of the Federal Register (CFR) Title 47 “Telecommunication”, Chapter I “Federal Communications Commission” (FCC) Regulations:
   2. Part 24, “Personal Communications Services”
   3. Part 27, “Miscellaneous Wireless Communications Services”
   4. Part 95, “Personal Radio Services”
   5. NFPA 72 “National Fire Alarm and Signal Code Regulations”
   6. Chapter 24, “Emergency Communication Systems (ECS)”

7. Pathway Survivability
    1) Two-Way Radio Communication Enhancement System
8. NFPA 1221 “Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems”
9. Houston Building and Fire Codes Sections 914 and 510.

C. Refer to Predictive Survey Design Report for coverage analysis.

1.03 DEFINITIONS

A. Definitions as described in section 270000 shall apply to this section.

B. In addition to those Definitions of section 270000, the following list of terms as used in this specification defined as follows:

1. “AHJ”: Authority Having Jurisdiction
2. “BDA”: Bi-Directional Amplifier
3. “BOM”: Bill-of-Material
4. “BTS”: Base Transceiver Station
5. “C/N”: Carrier-to-Noise Ratio
6. “DAQ”: Delivered Audio Quality
7. “DMR”: Digital Mobile Radio
8. “DAS”: Distributed Antenna system (synonymous with in-building antenna system)
9. “ECS”: Emergency Communication Systems (referenced within NFPA 72)
10. “ERRCS”: Emergency Responder Radio Communication System (referenced within NFPA 1221)
11. “FCC”: Federal Communications Commission
12. “Feeder”: Horizontal cable runs to antennas
13. “GROL”: General Radio Operator’s License
14. “GUI”: Graphical User Interface
15. “iDEN”: Integrated digital enhanced network
16. “LMR”: Land Mobile Radio
17. “NFPA”: National Fire Protection Association
18. “PCS”: Personal communications service
19. “PIM”: Passive Intermodulation
20. “PSN”: Public Safety Network
21. “PSRS”: Public Safety Radio System (referenced within NFPA 72)
22. “RF”: Radio Frequency
23. “Riser”: Vertical cable runs to remote amplifiers and horizontal / feeder branches
24. “RSSI”: Received Signal Strength Indication
25. “SMR”: Specialized Mobile Radio (synonymous with trunked radio or public access mobile radio)

26. “SOW”: Statement of Work

1.04 SYSTEM DESCRIPTION

A. System Description

1. The System, or “ERRCS”, shall reliably distribute RF signals for multiple first responder/emergency response wireless services throughout the specified frequency ranges and the specified coverage areas. The System shall be implemented based on proven technology that can seamlessly integrate with the rapid evolution of wireless technologies and business applications. The System shall be flexible and shall easily accommodate additional wireless services within the System’s frequency bands without requiring significant upgrades or system modifications.
2. The System shall include subsystems, equipment, components, transmission media, connection/ termination apparatus, etc., necessary for a complete operating system as described herein.
3. The System shall continuously distribute public safety radio signal throughout the building for 24 hours, minimum, during an event such as loss of utility power, as required per NFPA 1221. Therefore, the System requires continuous power with a runtime of 24 hours, minimum. The System requires dedicated circuit(s) to the equipment primary power source(s).
4. The active equipment and battery systems shall be electrically supervised and monitored by a supervisory service, or when approved the AHJ, shall sound an audible signal at a constantly attended location, as required 510.4.2.4 #3.
5. The System requires riser and feeder pathway survivability level 2 per NFPA 72 and 1221.
6. Riser and feeder cables shall be plenum rated.
7. Feeder cables shall be connected to riser cables via either coaxial couplers/splitters or to fiber remotes.
8. Riser cables shall route through a 2-hour rated assembly.
9. Connections between riser and feeder cables shall be made within the 2-hour rated assembly, and passage of feeder cables into/out of 2-hour rated assemblies shall be fire-stopped to 2-hour ratings.
10. The System shall have lightning protection.

B. Design Criteria

1. Frequency Range: The System shall support all the following frequencies.

General Government Services		
TX FREQUENCY	**RX FREQUENCY**	**CHANNEL NAME**
859.9375	814.9375	1-CC
859.4375	814.4375	2-CC
859.2625	814.2625	3-CC
858.9375	813.9375	4-CC
North East Public Safety Simulcast		
TX FREQUENCY	**RX FREQUENCY**	**CHANNEL NAME**
773.43125	803.43125	1-CC
773.13125	803.13125	2-CC
772.78125	802.78125	3-CC
771.55625	801.55625	4-CC
North West Public Safety Simulcast		

TX FREQUENCY	RX FREQUENCY	CHANNEL NAME
773.96875	803.96875	1-CC
773.65625	803.65625	2-CC
773.24375	803.24375	3-CC
772.80625	802.80625	4-CC

South East Public Safety Simulcast		
TX FREQUENCY	**RX FREQUENCY**	**CHANNEL NAME**
773.38125	803.38125	1-CC
772.93125	802.93125	2-CC
771.40625	801.40625	3-CC
771.63125	801.63125	4-CC
South West Public Safety Simulcast		
TX FREQUENCY	**RX FREQUENCY**	**CHANNEL NAME**
773.74375	803.74375	1-CC
772.59375	802.59375	2-CC
772.21875	802.21875	3-CC
771.84375	801.84375	4-CC
Downtown Tunnel Site		
TX FREQUENCY	**RX FREQUENCY**	**CHANNEL NAME**
770.30625	800.30625	1-CC
770.00625	800.00625	2-CC
769.75625	799.75625	3-CC
769.54375	799.54375	4-CC

2. Contact City of Houston HITS – Radio Communications Services and Harris County Radio Network Operation Center (RNOC) for specific frequencies required at specific project locations.
3. The System shall distribute RF coverage throughout interior spaces.
4. The System shall support public safety (including “First Responder”) wireless services and technologies, including the following:
    a. Local police department
    b. City police department
    c. County sheriff
    d. Fire department
5. The System shall have the capability for separate control over each service to allow adjustment and of control power levels without disturbing other services/operators.
6. The System shall support multiple services in a modular architecture so services can be added or removed without requiring new infrastructure, without readjustment of signal power levels, and disturbing existing services.
7. The System shall not impede any management features or functionality of any attached network and/or device management system.
8. The System shall allow for proactive management and end-to-end alarming of active electronics.
9. The System shall provide fault management information.
10. System Supervision
    a. The System’s electronic supervision shall monitor, at a minimum, the following:

1) Loss of normal AC power
2) Failure of UPS/battery charger
3) Low-battery status
4) Signal booster failure/failure
5) Donor antenna failure
6) Active RF emitting device malfunction/failure
7) Distribution antenna failure

b. The System shall audibly annunciate alarms generated by the supervision.

c. The System shall have a separate dedicated supervision panel located near the building's fire alarm control panel.

11. The Owner prefers that the System's antennas be mounted above ceiling grids. Coordinate the RF design and the antenna placement, and mounting with both the architect and the Owner throughout the project.

12. The System's transmission media can take many forms, from traditional off-air repeater or BTS to a tethered architecture consisting of a hybrid fiber base solution. The System shall extend the first responder / emergency services frequencies from the headend by interfacing to either a passive or active ERRCS that is deployed in each of the building structures.

13. The System shall interface with the Fire Alarm System, compliant with NFPA 1221.

14. The System shall monitor the power source, system status, and other critical aspects to the System's overall operation and shall provide alarming annunciation – all as required by the AHJ.

15. The System shall distribute public safety channels with -95 dBm (or stronger) signal strength (RSSI) throughout 95% of occupied building spaces and 99% in critical areas as defined in NFPA 1221 and IFC or as required by local ordinance and agencies, including local and city police, county sheriff, and fire departments. Confirm with the AHJ, Owner, and additional authorities' frequencies that will be in use at the time of facility opening.

16. The System shall have at a minimum 20 dB isolation between a donor antenna and all inside antenna with as defined in NFPA 1221 or as required by local ordinance and agencies, including local and city police, county sheriff, and fire departments. Confirm with the AHJ, Owner, and additional authorities' frequencies that will be in use at the time of facility opening.

17. The sound quality shall meet or exceed DAQ 3.0 ("Speech understandable with slight effort; requires occasional repetition due to noise or distortion") as defined in NFPA 1221.

18. The System and the associated wireless devices shall comply with the FCC and regional regulatory authorities' emission rules for wireless devices.

    a. Refer to: FCC advisory: "A Local Government Official's Guide to Transmitting Antenna RF Emission Safety Rules, Procedures, and Practical Guidance", FCC's OET Bulletin 65, FCC Rule 47-part 17 and (ANSI/IEEE C95.1-1992) Hazardous Emission document.

19. Existing Facilities: Existing facilities utilizing previously authorized wired ERRC communication systems shall be maintained as required by the code of record associated with the original construction and Chapter 11 of the currently adopted Houston Fire Code in lieu of installing an approved radio coverage system. Submitted plans for all remodels and lease buildouts of existing facilities shall include documentation in the code analysis sheet identifying compliance with ERRC.

20. New Construction: A pretest shall be conducted to determine whether the building has the radio coverage required by code, or a radio signal enhancing system is needed. When a DBA system is needed, ERRC plans must be submitted for our review as per PART 3 below. Prior to issuing the Certificate of Occupancy (*CO*) or approving the final inspection, facilities not otherwise exempted by PART 2 below, shall be tested by a City of Houston registered *ERRC* third-party special inspector using appropriately trained personnel. A copy of the special inspection report documenting *ERRC* compliance with the *Houston Fire Code*, shall be submitted to *BCE* at the following email address for review:HPC-RA@houstontx.gov. With prior approval from the *building official* and the *fire code official*, a wired communication system in accordance with Section 907.2.13.2 may be permitted to be installed or maintained for new construction in lieu of an *approved* radio coverage system. NOTE: Every special inspection report shall be from a City of Houston registered ERRC Special Inspector complying with the provisions of PART 1. The ERRC special inspection report shall clearly document compliance with all applicable code provisions specifically identified in Section 510 of the current adopted Houston Fire Code.

1.05 SUBMITTALS

A. Comply with Submittal procedural, quantity, and format requirements of section 270000.

B. Submittal Requirements with the Bid:

1. Statement of Work that describes the entire proposed scope
2. A brief description of the intended system, including manufacturer and major equipment.
3. A certificate from the manufacturer of the equipment to be installed stating that the ERRCS installer is trained and qualified on the equipment.

C. Submittal Requirements Prior to Start of Construction:

1. Initial on-site discovery survey report following NFPA 1221 Annex A testing guidelines
2. Product data submittal
3. Shop Drawings Submittal – Include the following in the shop drawing submittal:
4. System or functional block/line diagrams
5. Plans showing the location of the following components: Donor antenna, indoor antennas, couplers, splitters, cable routes, remotes/BDAs, and head-end equipment.
6. Mounting details, and other installation information – identify construction elements that would affect the system’s performance (such as metallic ceiling materials).
7. Coverage plans, showing the design RF coverage (signal strength) for each frequency band described in section 1.04 (listed above) using iBwave or another industry acceptable RF modeling tool and provide the following:
    1) Optimized iBwave model with outdoor discovery survey collected data
    2) Signal strength RSSI, with color coded compliance legend
8. Wall and rack elevations, showing equipment layout, space requirements and integration with other systems (outside the scope of the ERRCS)
9. Installation details for antenna mounting, specialty cable hangers, and other components unique to the system, and other information that depicts the intended installation
10. Compliance to permitting agency requirements

D. Submittal Requirements Prior to Acceptance Testing:

1. Current calibration and test data on the test equipment to be used in the system commissioning.
2. Acceptance Test Plan (ATP): This submittal shall describe in detail the procedure for testing the System's performance and balancing the System's signal strength, including a description of the test data (or an example of the test report). The procedures and results shall demonstrate the desired services have been successfully deployed and tested. The ERRCS must be deployed with the AHJ criteria and approval.

E. Submittal Requirements at Close Out:

1. As-Built Drawings, including
   a. Donor antenna, grounding and lightning protection details
   b. Cable routing, splitters, couplers and coverage antenna locations
   c. Active component locations, layout and configuration
2. Test Reports
   a. AHJ: Submit a confirming letter accepting the ATP results
   b. Cable test results – includes every cable segment
   c. Validation survey report
3. Operations and Maintenance Manual (refer to section 270000 for contents)
4. Warranty Documents
   a. Submit Contractor's System warranty, including procedures and contact information for service calls under warranty.
   b. Submit Manufacturer's Extended warranty, including procedures and contact information for service calls under warranty.
5. Integration of components and pathways into the Building Information Model (BIM)

F. City of Houston Plan Review Submittal Process:

1. Where a facility is not otherwise exempted by PART 2 above; *ERRC* plan submittals and third-party special inspection code compliance verification is required. All *ERRC* plan submittals shall be sealed, signed and dated by a Texas Professional Engineer. *ERRC* plan submittals may address the required code provisions using one of the following submittal methods
   a. Include ERRC plans designed, sealed, signed, and dated by a Texas Professional Engineer in the submitted construction documents for new buildings, additions, buildouts, and remodels of existing buildings or lease spaces, or
   b. Provide a note on the code analysis sheet indicating compliance with the code provisions of Section 510 of the adopted *Houston Fire Code* and include a completed deferred submittal *Form No. CE-1086 Plan Review Request for Deferred Submittal* in the submitted construction plans requesting deferred submittal of appropriately designed *ERRC* plans.

G. City of Houston Deferred Submittal ERRC Plan Review

1. The Texas engineer sealed deferred submittal plans for ERRC may be reviewed and approved through the commercial one- stop section where authorized by a plan review supervisor or manager. The one-stop plan analyst will review the submitted documents for compliance with the ERRC provisions of Section 510 of the Houston Fire Code. Additionally, Texas engineer sealed structural plans and anchorage details addressing the

proper Houston wind speed and dead loads for all transmitter and/or receiver towers or other equipment installed on the exterior of the building, shall be included.

2. Where the scope of a new project proposes the installation or replacement of ERRC equipment required to meet the code provisions of the Houston Building and Fire Codes, the project shall be a building permit (13) with a permit fee based on the cost of construction, the same as any other remodel project. Where a deferred submittal request is authorized by a supervisor or manager, the cost of the EERC system design, materials, and installation shall be included on the original or master project and the plan review may be completed as a minimum fee (S9) plan review attached to the original or master project, the same as any other deferred submittal request.

3. At the request of customers, BCE provides an ERRC special inspection report template which includes a checklist of minimum required specific information expected to be addressed by all third-party ERRC special inspection reports.

4. At the completion of the ERRC signal booster system installation and prior to issuance of the certificate of occupancy or a final inspection, the ERRC signal booster systems shall be tested for ERRC compliance verification by a third-party special inspector registered with the City of Houston. ERRC special inspection reports shall be submitted directly to the Customer Assistance & Code Development Office by email at: HPC-RA@houstontx.gov.

H. City of Houston Plan Review and Special Inspection Exemptions

1. Although all structures require compliance with the Houston Construction Code provisions for ERRC. Facilities that meet the following are exempt from the required plan review and third-party special inspection verification process:

a. Buildings without basements, and

b. Three stories or less in height, and

c. Having an aggregate total building area not exceeding 50,000 square feet.

1.06 QUALITY ASSURANCE

A. Comply with Quality Assurance requirements of section 270000.

B. Comply with manufacturers' specifications.

C. ERRC Designer Requirements

1. The code provisions of Section 510.4.2.9 Houston IFC (2015) require the ERRC system designer to be:

a. A Texas Professional Engineer with appropriate training (Plans shall be sealed, signed and dated.)

D. ERRC System Installation and Testing

1. The ERRC system may be installed, and special inspection testing completed by:

a. A Texas Professional Engineer with appropriate training, or

b. A valid FCC Licensed General Radio Telephone Operator registered with the City of Houston as an ERRC Special Inspector; with in-building emergency radio system certification issued by a nationally recognized organization, school or the emergency radio system manufacturer of the equipment being installed.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with Delivery, Storage, and Handling requirements of section 270000.

1.08 WARRANTY

A. Comply with the Warranty requirements described in section 270000. Warrant the System to perform as described within this section, including workmanship, components, electronics, and signal coverage – herein “warranty period”.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Comba

B. JMA Wireless

C. SOLiD Technologies

D. SureCall

E. Or equal

2.02 SUBSTITUTIONS

A. Comply with the Substitution requirements of section 270000.

2.03 ANNUNCIATOR

A. Displays status of BDA, Donor Antenna, AC Power, Battery Capacity, Battery Charger, and System Status.

B. Includes a form C relay for interface with fire alarm system

C. NEMA-4 enclosure

D. Internal battery back-up

E. Manufacturer, or equal:

1. DASalert #1221

2.04 TEST EQUIPMENT

A. Specifications

1. Accuracy: ±1 dB (across basic RF input power range)
2. Dynamic range: -120 dBm to -20 dBm at 30 kHz
3. Frequency range: 150 MHz to 900MHz
4. Technologies: LMR, and P25
5. Connection: Bluetooth or USB to Windows laptop or Android tablet
6. Power: Hot-swappable batteries

B. Manufacturers, or equal:

1. Anritsu MS2720T spectrum analyzer
2. PCTEL – IB*flex*
3. Keysight – Nemo

4. FalconSmart – Falcon Kitt

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with the Execution requirements of section 270000.

B. Comply with manufacturers specifications.

3.02 PRE-INSTALLATION AND COORDINATION

A. Prior to design, conduct an on-site discovery survey within the building and outside the building of existing signal strength of all required frequency bands identified in 1.04 “System Description” above. The onsite survey will consist of the following:

1. Locations
   a. Record signal strengths of required frequency bands present at the optimal location for a donor antenna.
   b. Each floor of the building shall be divided into a grid of equal test areas.
      1) Floors with less than or equal to 128,000 sq-ft use a grid of 20 approximately equal test areas between 20 to 80 ft each.
      2) Floors with greater than 128,000 sq-ft use equal grids that have a maximum of 80 ft.
   c. Downlink received signal level measurements will be recorded in the coverage area using a continuous wave test signal. Measurements will be collected using a spectrum analyzer and a dipole antenna.
   d. A test location approximately in the center of teach test area shall be selected for the test. Once the location has been selected, the location shall represent the entire test area.
2. Equipment Requirements
   a. Spectrum analyzer with unity gain (0dB, frequency specific) dipole receive antenna must be approved by the project engineer.
   b. Stabilize the test equipment in the test environment for a minimum of thirty minutes prior to calibration. For example, temperature variations can void the calibration.
   c. Use a spectrum analyzer to capture and present signal strength. It is preferable to present signal strength as a graphical “heatmap”.
   d. Save screen shots during testing that show frequency span +/- 20 MHz relative to the center / measured frequency.
3. Documentation
   a. Documentation shall include the exact location of measurement marked on the grid print.
   b. Screen shots must be taken in all designated grid spaces. If more than one reading is saved per grid zone, saved results shall be distinguished from one another using Grid# “A”, Grid# “B” etc.
   c. Submit the testing results to the project engineer for analysis and reporting.

B. Detailed System Design:

1. Use the requirements of this section to complete the detailed design of the System. Design shall include computer RF modeling and site surveys.

2. The detailed design shall deliver the pre-construction submittals, including iterations for the Owner's review and sign-off.
3. Design RF signal levels to sub-room precision for rooms within the defined coverage areas. Obtain compatible drawings from architect. If drawings are within BIM, then modify the BIM model for use in wireless modeling including the creation of 2-D floor plans, RCP plans and elevations.

C. Coordinate RF rebroadcasting agreements with AHJ.

D. Represent the Owner during negotiations with the AHJ to obtain their approval.

E. Examination and Preparation

1. Examine equipment rooms, pathways, power service, NFPA 72 and NFPA 1221 compliance, and other aspects for completeness, the compatibility with the work of this section, and the readiness for connections with the work of this section.
2. Confirm that the fire-alarm system's annunciator is ready for connection to the System.

3.03 PRE-INSTALLATION AND COORDINATION

A. Coordinate RF rebroadcasting agreements with AHJ.

B. Represent the Owner during negotiations with the AHJ to obtain their approval.

C. Examination and Preparation

1. Examine equipment rooms, pathways, power service, NFPA 72 and NFPA 1221 compliance, and other aspects for completeness, the compatibility with the work of this section, and the readiness for connections with the work of this section.
2. Confirm that the fire-alarm system's annunciator is ready for connection to the System.

3.04 PROJECT MANAGEMENT SERVICES:

A. Assign project manager, a single-point-of-contact, to this project with overall responsibility for communications and ultimate delivery of contracted materials, installation, performance criteria, and services. This PM shall be responsible for interfacing with the Owner, AHJ, the General Contractor, and their own subcontractors.

B. Represent the Construction Team to coordinate on-site construction activities with the General Contractor.

C. Close out the project with the Owner.

3.05 INSTALLATION

A. Coordinate the installation and schedule with the Owner, General Contractor and electrical contractor prior to the start of installation activities. Once the Owner and General Contractor have accepted the coordination and schedule, proceed with installation.

B. Coordinate the location of and power service to a NEMA 4 type cabinet. Anchor the cabinet to the building structure per the project's approved methods.

C. Install active signal components and battery systems (used for emergency power) in a NEMA 4 type cabinet.

D. Meet with the Owner to discuss their needs for monitoring the System. Set up the electronic supervisory system (used to monitor signal booster components, emergency power and battery systems) per the Owner's requirements.

E. Mast and Donor Antenna Installation

1. Coordinate mast location with adjacent equipment so that other constructions do not obstruct the signal, and that the mast will not physically interfere with other roof-top equipment.
    a. Where a permanently installed mast location isn't available in order to guarantee adequate signal strength, use of a weighted antenna mast system may be used.
    b. For weighted antenna masts, verify with the structural engineer that the weight does not exceed the roof's limits, and, confirm wind-load requirements with the structural engineer.
2. Weather-seal penetrations.
3. Bond lighting arrestors to grounding system.
4. Secure cabling extending from weather-heads/penetrations to antenna mast in such a manner that the cable can not be tripped over, or otherwise damaged by personnel servicing roof-top equipment.

F. Indoor Antenna Installation

1. Mount according to manufacturers' recommendations.
2. Mount at locations identified within ERRCS design drawings. Avoid mounting locations as follows:
    a. Adjacent to metal materials
    b. Adjacent to RF signal sources
3. Cable paths to antennas shall match ERRCS design drawings.
4. Deviation of installation details and/or locations must be coordinated with ERRCS design engineer.

G. Change default passwords in accordance with the Owner's direction.

H. Install latest software versions, firmware, and security patches.

I. Disable unused communication ports, protocols and access accounts.

J. Test the following during installation: Return Loss (RL) and Distance to Fault (DTF)

K. System Balancing: Balance system component (e.g., antenna) signal strength to the device signal levels.

L. Alert the AHJ prior to bringing the system operational.

M. Manage FCC License: Acting as a representative of the Owner, obtain required licenses for operation under FCC Regulations.

N. Do not install amplification systems capable of operating on frequencies licensed to any public safety agency by the FCC without prior coordination and approval by the AHJ.

3.06 LABELING

A. Refer to 27 05 53

B. General Requirements

1. Label equipment, components, and cables.
2. Labels shall be permanent.
3. Text shall be machine-generated; handwritten labels will not be accepted.
4. Labeling, label colors, and identifier assignment shall conform to the TIA-606 standard. Coordinate labeling and identifier assignment with the Engineer or Owner.
5. Submit a labeling plan for approval prior to labeling work

C. Equipment Labeling

1. Affix labels to equipment (such as fiber remote units) such that they will be clearly visible.

D. Cable Labeling

1. Affix label as close as practical to each end of each cable.
2. Cable labels shall fully wrap around cable jackets resulting in a self-laminating result.

E. Antenna Labeling

1. Affix labels to antennas such that they will be clearly visible.

3.07 ACCEPTANCE TESTING / VALIDATION SURVEY

A. Complete acceptance testing in accordance with the approved Acceptance Test Plan (ATP). Only a qualified person or persons familiar with ERRCS and associated data collection tools shall test the System.

B. Perform an on-site survey to validate RF coverage (signal strength) throughout coverage areas (listed in Part 1) using approved test equipment.

C. Testing Procedure

1. Verify that remote units for the area under test are on.
2. Record signal strengths of required frequency bands present at the donor antenna.
3. Each floor of the building shall be divided into a grid of equal test areas
   a. Floors with less than or equal to 128,000 sq-ft use a grid of 20 approximately equal test areas between 20 to 80 ft each
   b. Floors with greater than 128,000 sq-ft use equal grids that have a maximum of 80 ft. It is recommended that the floor be subdivided into sectors each having an area less than or equal to 128,000 sq-ft, and each sector be tested individually with 20 ft grid cells in each sector.
4. A test location approximately in the center of teach test area shall be selected for the test. Once the location has been selected, the location shall represent the entire test area.
5. Downlink received signal level will be recorded in the coverage area using a continuous wave test signal. Measurements will be collected using a spectrum analyzer and a dipole antenna.
6. Signal strength and link spectrum: Must meet or exceed all critical areas and less than nine nonadjacent and/or six adjacent cell failures.

7. DAQ: Must meet or exceed all critical areas and not more than two non-adjacent grid cells failures. If two adjacent areas fail the DAQ test then grid should be halved and retested with no more than eight nonadjacent and/or five adjacent cell failures

D. Equipment Requirements

1. Testing equipment must be calibrated within the past 12 months.
2. Allow test equipment to stabilize in the test environment prior to calibration for a minimum of thirty minutes. Changes in temperature can void the calibration.
3. Verify that all remote units for the area under test are ON.
4. Test frequency and power measurements shall be time stamped.
5. Use a spectrum analyzer to capture and present signal strength, preapproved by the project engineer.
   a. Verify the spectrum analyzer is set to unity gain (0dB, frequency specific) so that the combination of analyzer and its antenna do not artificially increase measurement results.
   b. Present signal strength as a graphical “heatmap”.
6. Site walk screen shots shall be saved with frequency span +/- 20 MHz relative to the center / measured frequency.

E. Documentation

1. Exact location of measurement must be marked on the grid print.
2. Screen shots must be taken in all designated grid spaces. If more than one reading is saved per grid zone, saved results shall be distinguished from one another using Grid# “A”, Grid# “B”, etc.
3. Produce a validation survey report documenting the results including heat maps of the following:
   a. Signal strength (RSSI)
4. Report testing results to the project engineer for analysis.

3.08 FINAL INSPECTION

A. Participate in a punch walk with thee engineer to demonstrate that the work complies with the requirements of this section.

B. Submit Certificate of Compliance with manufacturers specifications.

C. Submit final testing documentation to and obtain acceptance from the AHJ. Include these documents in the as-builts.

3.09 TURNOVER AND TRAINING

A. Pre-emptive Maintenance Minimum Requirements: Perform the following just prior to closeout.

1. Clean filters, vents, and equipment components that may accumulate dust and dirt.
2. Organize and manage cables and cords that have been placed.
3. Update firmware with latest versions.
4. Document and photograph any conditions that may affect the continuing function and long-term operation of the System and report to Owner.

B. Present the completed system and wireless services to the Owner, including functionality, features, ongoing maintenance, and warranty procedures. Demonstrate to Owner and engineer, system operation, including signal strength at selected locations. Turnover at least one set of both electronic and printed records, per the Owner's request.

C. Comply with training requirements of section 270000. For this System, provide up to 4 hours of training for the Owner.

3.10 WARRANTY PERIOD MAINTENANCE

A. Correct deficiencies within 24 hours of notification during the warranty period.

3.11 EXTENDED SERVICES

A. Submit costs for extended services (additional service levels beyond the warranty period) as follows:

1. One-year, two-year, and three-year service with quarterly pre-emptive maintenance calls and same-day issue response
2. One-year, two-year, and three-year service with quarterly pre-emptive maintenance calls and 24-hour issue response
3. One-year, two-year, and three-year service with quarterly pre-emptive maintenance calls and 48-hour issue response

3.12 PROJECT CLOSEOUT

A. Refer to 27 00 00

END OF SECTION