

SECTION 27 51 23 – INTERCOMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish and install, as hereinafter specified, a complete centrally controlled intercommunication system including wiring, central console, loudspeakers, paging interface for connection to the phone system, connection, clock system connection, etc., all ready for operation. The intent of these specifications is to provide complete and satisfactory operating systems for the pickup, amplification and reproduction of voice and/or music. The central system shall be of the microprocessor-controlled type. All equipment and installation material required for a complete and operational system shall be furnished whether enumerated herein.
- B. **This is a phase project. All additional accessors, wiring, time, programming, etc. shall be provided as required so that there is a complete and functioning intercommunications system at the end of each individual phase. All features of the system shall be available throughout the construction. Refer to the Phasing drawings for a complete understanding of the scope of the phases for the project.**
- C. Work Included: The scope of work of this section consists of the design, installation, and programming of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances, and services necessary and/or incidental to properly complete all work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Architect and Owner, as being required and in general, is as follows:
 - 1. Supervised Network Intercom and Paging System, including but not limited to:
 - a. Supervised network amplifiers, back boxes, and all equipment, cabling and support required to interface the public-address system to the Owner's telephone system via Interface to be coordinated with owner's phone vendor.
 - b. Supervised network system speakers, and ceiling mounted speakers, wall mounted horns, both interior and exterior.
 - c. Emergency call-in switches, programmed as directed by the Owner.
 - d. Cabling to support the Public-Address System (NOTE: category 6 cable must conform to Division 27 "Communications Cabling"). **All patch cables for system must be included. Coordinate network data needs with owner for Owner provided Network Switches.**
 - e. Interconnection to master clock system.
 - f. Supervised network PA override signal to local sound systems.
 - g. Interactive Graphical User Interface (IGUI) supporting a pictorial view of architectural room locations on a map, and controlling intercom functions including zone or all page, dynamic zone assignments, answering intercom call-ins, selecting and distributing program sources to any and all zones. IGUI will also annunciate, locate and indicate loss of communication to all supervised network devices including speakers, amplifiers, emergency messaging display/clocks, and notification switches.
 - 1) Programming of the system to allow graphical user interface shall be provided as part of the bid.
 - h. Emergency communication shall be initiated by the local console or from a centrally located district office via a District Wide Emergency Communication platform (coordinate connection

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with owner). Emergency communication shall include but not be limited to, pre-recorded audio, live audio, emergency textual message display activation, computer pop-up notification, SMS Text message, and email.

- D. It is anticipated that the majority of devices will be IP based. Review specifications to determine where analog devices are acceptable.
- E. All equipment, including network electronics, shall be provided as part of this specifications. Only a single connection to the Owner's network is allowed for programming purposes.
- F. Provide interconnections as listed in part 2.
- G. Provide product demonstration and training as listed in part 3.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product literature and installation instructions with system wiring diagrams. Provide a complete listing of all major components required for a complete and fully operational system.
 - 1. Provide floorplan clearly identifying where intercom components including, but not limited to head-end equipment, amplifiers, speakers (IP and analog), call-in switches, volume control, etc. are located throughout the building.
 - 2. Floorplan shall clearly identify where data jacks are required, and labeling to be used for jacks.
- B. Maintenance Data: Include data in the maintenance Manual specified in Non-Technical Specifications and Division 26 "Basic Electrical Requirements."
- C. Maintenance Instructions: Submit manufacturer's printed instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under use conditions. Submit three complete sets of operating instructions including wiring and circuit diagrams.
- D. Inventory: Supply with the manuals an inventory of the equipment provided.
- E. When preparing submittals and any required final programming, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal, when a schedule is available, to reflect the proper room numbers.
- F. Submit un-executed contract for full specified warranty, indicating parts and labor to be covered to be reviewed prior to installation. At substantial completion, warranty must be fully executed between installing vendor and owner.

1.3 QUALIFICATIONS

- A. Supplier: The supplier must have a minimum of five years' experience in the design and installation of systems equal in size and type required by this project. The supplier must maintain a local service organization within a one hundred (100) mile radius of the installation with spare components and accessories.
- B. The supplier must be the authorized representative of the equipment manufacturer supplied and have full-time technicians trained and certified in the installation and service of the equipment supplied.

1.4 REGULATORY REQUIREMENTS

- A. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction, and that portion of the NEC which pertains to installation and construction of specified products.
- B. FCC Compliance: Comply with U.S. Federal Communication Class B standard for allowable radiation from equipment and wiring.
- C. Institute for Electrical and Electronic Engineers (IEEE): Comply with all applicable standards for audio, video, and data networks.
- D. Americans with Disabilities Act (ADA): Accessibility Guidelines for buildings and Facilities.

1.5 MAINTENANCE SERVICE WARRANTY

- A. Special Project Warranty: Submit a written warranty, executed by the contractor, installer, and the manufacturer, agreeing to repair or replace equipment which fails in material or workmanship within the specified warranty period. This warranty shall be in addition to and not a limitation of other rights the owner may have against the contractor under the contract documents.
- B. Warranty of Conformance with Specifications: The contractor shall warrant that all specified functions shall be provided even if functional omission is not discovered until the end of the warranty period. This shall warranty full function of the system even if the owner does not fully utilize the capabilities of the system initially.
- C. Full parts and labor warranty period shall be five (5) years after the Date of substantial completion and useful implementation of the system. Warranty shall include on-site service labor and loaner parts to keep the system fully operational during the warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Telecenter equipment manufactured by Rauland-Borg Corp. and others as listed shall be considered as meeting these specifications. No other manufacturer shall be acceptable.
 - 1. **Contractor shall contract with owner's current vendor, Sage Technology Solutions Inc. Contact Charlie Mowrer 717-653-6641.**

2.2 GENERAL DESCRIPTION OF NETWORK INTERNAL COMMUNICATION SYSTEM

- A. **IP based devices shall be provided, where indicated in these specifications and on the drawings. Analog devices may be used, only where indicated or with written prior approval.**
- B. Supply and install a complete supervised network-based intercom system. Field wiring shall be per Division 27 "Communications Cabling." All station equipment shall utilize standard RJ-45 modular connections. All remote devices utilizing standard structured cabling shall be capable of PoE (Power over Ethernet).
- C. The system shall be capable of interconnecting with the building LAN (Local Area Network). This connection shall be minimal and utilize only one Ethernet 100 Mbps (or optionally 1 Gb) connection per station to accomplish all intercom operations.

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- D. Provide a separate circuit for each room and administrative office so each room, speaker, amplifier, and emergency messaging display/clock can be individually addressed.
- E. Overall intercom communications network shall utilize Ethernet or VoIP communications between all major components: administrative consoles, intercom stations, amplifiers and individual paging speakers, and network switches. Systems not utilizing Ethernet or VoIP communications protocol to each end-point device will not be acceptable. Systems not capable of supervising all networked devices including network amplifiers, network speakers, notification switches, and emergency messaging display/clocks will not be acceptable.
- F. The network shall support a VLAN configuration to separate activity in the intercom system from other in building LAN traffic. In locations where the supervised network communications system will be considered as part of the facilities life safety systems, a dedicated and isolated network shall be required.

2.3 DESCRIPTION OF NETWORK INTERCOM / PA FEATURES

- A. The system specified is based on the Rauland-Borg Telecenter U Supervised Network based Communications System as outlined below. It shall be installed and programmed by Sage Communications.
- B. The system shall utilize a decentralized network structure, not requiring any head-end equipment, central server, or any other control hardware to maintain system operation.
- C. All station devices shall receive power and data through a Power-Over-Ethernet switch. Once plugged into the LAN through a Power-over-Ethernet network switch, all networked devices shall be immediately operational and as applicable shall be able to place or receive calls and pages from Stations as well as page all devices in the network. Consoles, intercom stations, clocks, emergency displays, or speakers connected to the network shall not require any network configuration or administration to function.
- D. Speech shall be transmitted in the frequency range from 50 Hz to 7 kHz and shall use a maximum of 128 kbps of bandwidth during a call.
- E. Intercom communications between consoles and system devices shall be non-blocking with no channel restrictions or limitations (other than network capacity) to the number of simultaneous conversations at any time between pairs of intercom stations, intercom station to console, console to console, console to speaker or zone of speakers, program source to a speaker or zone of speakers, or bell tones to a speaker or zone of speakers regardless of number of stations or consoles.
- F. Any and all device shall have the ability to have its programming downloaded, individually or simultaneously via the network. Programming shall be downloadable in a series of human readable, industry standard comma-separated values (CSV) files that can be saved and edited using common spreadsheet applications. Consoles, intercom stations, clocks, displays, and speakers residing on a network shall have the ability to update their programming, simultaneously from a CSV file. Furthermore, all devices shall also have the capability to be configured directly, such that device numbers, names, zones, and call-in destinations can be altered in real time without the uploading or downloading of their programming. System shall be capable of uploading firmware updates to all device classes simultaneously, via the network, without the requirement of tools, by authorized technician or qualified facility technician or representatives.
- G. Audio communications between all devices shall be accomplished with latency values of a maximum of 0.1 seconds and connection times of 0.01s for 1 to 500 speakers.
- H. The system shall support a minimum of 50 channels of simultaneous duplex communication paths on the intercom system LAN, plus a minimum of 10 simultaneous duplex channels for PBX integration.

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- I. System shall provide multiple IP addressable modules for intercom, paging and relay activation.
 - 1. All modules are POE 802.3af compliant
 - 2. All Modules support DHCP
 - 3. All Modules connect to network with a single RJ45 connector
- J. IP-addressable Zone Paging Module
 - 1. Zone paging module shall connect one or multiple speakers for district all page, all page, zone paging, bells, audio events and, emergency notification.
 - 2. Zone Paging Modules shall be rack and/or wall mountable.
 - a. Zone paging modules shall either be installed at the speaker, or in the data closet. Zone paging modules wall-mounted above the ceiling shall not be acceptable.
 - 3. Zone Paging modules shall be able to belong to one or more of 50 independent zones for live paging, bells, pre-recorded audio and emergency notification
 - 4. Provide Rauland Telecenter TCC2011a Paging Module as required and identified in the specifications below. Interface with high power amplifier as specified below.
 - 5. Provide Modules to mute remote sound system with a dry contact closure and to insert paging audio into the local system.
- K. IP Addressable Aux I/O Module.
 - a. Aux I/O Module shall have two input contacts and two output contacts.
 - b. Input and output contacts are individually addressable.
 - c. Aux I/O Module shall be wall and rack mountable.
 - d. User can program relays to be activated manually, through an event/bell schedule and during emergency notification.
 - e. Provide Rauland Telecenter TCC2033 Auxiliary Input/Output Modules as required to accommodate listed functions.
 - f. Install one (1) Aux I/O Modules for interface with two (2) contact closure inputs from the District's Security System for initiation of Emergency Protocols. Can play a pre-recorded message along with initiating out-dial sequences.
- L. Programmed Zones
 - 1. The building, at a minimum, shall have the following zones. All programmed zones shall be coordinated with the owner prior to final programming.
 - a. Upper level classroom wing.
 - b. Lower level classroom wing.
 - c. Classrooms around gymnasium.
 - d. Gymnasium.
 - e. Cafeteria.
 - f. Office area.
 - g. Exterior speakers, with each face on a different zone.

2.4 SUPERVISED NETWORK ADMINISTRATIVE CONTROL CONSOLE

- A. A full color screen with 64 soft keys, 3 line select, volume control, push to talk, speakerphone mode and left/right and up/down scrolling.

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- B. Audio paging access from any Console to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire school.
- C. Programmable soft key access from any console on the system to initiate alarm signals within the school to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular system functions.
- D. Programmable soft key access from any console to automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
- E. Ability to perform intercom to any single IP Addressable Speaker Module.
- F. Ability to display 3 call-ins at a time on the screen, with unlimited number of call-ins annunciating and the ability to scroll to view all call-ins.
- G. Ability to upgrade a call-in via soft key
- H. Ability to change which bell event schedule(s) are active on current day.
- I. Programmable soft key access from any console for activating relays, school wide
- J. Ability to maintain, along with controller and other IP Modules system functions, including intercom, bells and paging in the event of district wide connection loss
- K. Provide (3) Rauland TCC2045 Telecenter Administrative consoles. Provide one at owner designated location with the Program Origination Module at the Office remote rack, and the remaining two (2) where directed
 - 1. Program touchpoints on administrative consoles for simple program distribution and event initiation including program or microphone audio distribution to all speakers A) within the building or B) within corridors or common areas. Schedule a coordination meeting with the owners (through the construction manager) to discuss programming options and determine which features to apply to the phones programmable feature buttons.
- L. Provide one (1) Rauland Model TCC2055 Program Module and one (1) Rauland Model TCC2033 Aux Module as required for auxiliary inputs.

2.5 SUPERVISED NETWORK INTERCOM SPEAKER

- A. The Supervised Network Intercom Talk-Back Speaker (subsequently referred to as Network Speaker) shall be Quam Model System 5/8RJ lay in type 1' by 2' with bracket for mounting TCC2011a IP interface module. Speaker has RJ45 jack to mate with TCC2011a output. Supply Plenum rated RJ45 patch cords as required to connect to CAT6 and Call-in/Check-in switch.
 - 1. Where spaces require multiple speakers, slave speakers may be used, provided there is sufficient power to drive speakers over ambient noise and allow clear intelligibility.
 - 2. Call-in/check-in switches shall be located where directed on the documents.
 - 3. Where identified, provide volume controls as manufactured by Atlas, Model AT10PA. Interface Priority Relay to Rauland Aux I/O module contact closure for override during emergency all-call and other specific events as directed by owners. Priority Override must be user definable.

- B. Speaker spacing shall be as defined by manufacturer to provide maximum intelligibility.
- C. The Network Speaker shall provide transmission of HD audio as generated from intercom console and/or associated push-to-talk, intelligent microphone, supervised network amplifier, or program sources connected to the network.

2.6 SUPERVISED NETWORK AMPLIFIERS

- A. The Supervised Network Amplifier (subsequently referred to as Network Amplifier) shall provide a minimum of 25 watts for paging and public address and shall be capable of utilizing analog amplifiers to increase the amount of amplified signal from the network amplifier. The Network Amplifier shall be connected to the network switch by an RJ45 connector and shall receive signals directly from the network.
 - 1. Provide where required to accommodate analog speakers. Analog speakers shall be provided only where indicated; otherwise, IP based speakers are to be installed.
 - 2. Provide individual zones for each space, as well as each face of the building (exterior), unless noted otherwise.
 - 3. Network amplifiers must be installed in data closets, unless noted otherwise, or approved by the Owner, Architect or Engineer in writing. Provide with rackmount kits, and located, where directed by the owner, in data racks. Provide clear label on amplifiers to indicate what spaces they feed.
 - a. Additional analog amplifiers may be provided to expand amplification power for applicable zones; however, the zoning must be maintained.
 - 4. Amplification shall be provided with 25% spare for each zone.
- B. The Network Amplifier shall be supervised and, in the event that network communications is lost, notification shall be provided.
- C. Supervised Network Amplifiers shall be provided, where required, for analog speakers; however, analog speakers shall only be provided where specified or indicated on the drawings.
- D. Expected areas for analog speakers and network amplifiers include library, cafeteria, gymnasium and building exterior.
 - 1. Where analog speakers are located in spaces not identified to receive analog speakers listed above due to installation constraints (i.e. surface mounted or installed in hard ceilings), provide additional interface module at the speaker and connect.

2.7 ANALOG LOUDSPEAKER ASSEMBLIES:

- A. Where standard speakers are shown on the plans to be recessed in hard ceilings provide Rauland Model ACC1400 with ACC1100 backbox.
- B. The general area paging horns shall be Quam model H16/SVP with square baffle and surface backbox.
- C. The gymnasium paging horns shall be Quam model System6VPS with square baffle and surface backbox mounted to steel and angled down and out using Peavey Versamount 35 multi-angle bracket.
- D. Exterior and wet listed paging horns shall be Lowell Model LUH-15T. Provide Lowell Model LUH-Box surface stainless steel back box on existing walls. Provide stainless steel recessed kit on new walls. It shall incorporate an integral driver combined with a re-entrant heavy-duty aluminum horn assembly. It shall contain a built-in, weather-proof line matching transformer for 25 and 70-volt application and be provided

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with a screwdriver adjustable impedance-wattage switch. Exterior grille and back box shall be provided with a custom color finish to match exterior brick, block or wall finish. Color shall be selected by the architect.

1. **The custom color finish shall be achieved by providing a custom powder coating, applied to all exposed portion of the speaker (cover plate, grille, surface box, etc.) The contractor shall be responsible to send applicable products to a powder coating shop to apply the finish at no additional cost to the Owner.**

- E. The Surface Mounted Loudspeaker Assemblies shall be Quam Model System 2VP with square white steel baffle, 8" speaker, 70volt xfmr, and square white slope front surface mounted steel backbox. Provide in quantities and locations as shown on the plans.
- F. Where analog speakers are located in spaces not identified to receive analog speakers listed above, provide additional interface module at the speaker and connect.

2.8 NORMAL/EMERGENCY CALL-IN / CHECK-IN STATIONS

- A. Provide Rauland Model 603302 Normal/Emergency Call-in / Check-in stations. This single gang device shall be equipped with a gray normal call button, and a red emergency call button. In the event an emergency protocol has been initiated, pressing the gray "normal" button shall remove the associated classroom number from the Administrative-Console's check-in queue. Provide in quantity and location as shown on the plans. A pre-terminated plenum rated patch cable shall be provided from the TCC2011a mounted to the back of the intercom speaker in the room to the 603302 Call-in/Check-in station.

1. Verify programming of station with owner.

2.9 SUPERVISED DESKTOP MICROPHONE CONSOLE

- A. Provide one (1) supervised desktop microphone to be used to provide an all-page for the facility.
 1. Locate microphone where directed by owner and provide data connection as required.
- B. The microphone shall connect to the Virtual Master Control Console using standard CAT6 cabling.
- C. The microphone shall be provided with Built-in speaker for intercom communications.
- D. The microphone shall be provided with electret gooseneck microphone with unidirectional polar pattern.

2.10 INSTALLATION SPECIFIC CONFIGURATION

- A. MDF: Provide all required interface equipment to interface with the telephone system, security system and other specified systems.
 1. Provide interface modules and amplifiers as required for exterior speakers and other local areas of analog speakers. Local IDF's may be used for interface modules and amplifiers for speakers more remote from the MDF.

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- B. Office Work area, where indicated: Provide small desk-mounted rack, sized appropriate for all equipment, to include:
 - 1. One (1) Tascam model TU-690 rack mountable AM/FM Tuner or equal.
 - a. AM-FM antenna shall be half wave stainless steel whip type with BNC or F-connector termination to down lead. A weather-proof box with 11/16th mounting hole, securely fastened to a mast extending a minimum of two (2) feet above the surface of the roof, shall be provided. Lightning arrestor shall be furnished and connected by a No. 12AWG conductor to an approved ground strap making a good connection to the grounded metallic antenna conduit and other suitable ground. Lightning protection grounding system shall be furnished and installed by the electrical contractor and shall be as recommended by the National Electrical Code and as approved by the Middle Department Rating Association. Approved RG59-U coaxial cable shall extend from the weather-proof box through conduit to the console location. Provide one for each tuner installed on the project.
 - 2. Administrative consoled as directed above.
 - 3. All-page microphone storage.
 - 4. Auxiliary inputs for connection of a personal phone, iPOD or other music device.

2.11 WIRELESS MASTER CLOCK

- A. Refer to Division 27 "Wireless Clock System" for additional requirements.
- B. Provide an atomic clock synchronized central controller unit having the following capabilities:
 - 1. Ability to automatically adjust for Daylight Saving Time.
 - 2. Ability to bypass Daylight Saving Time, but to still keep synchronized to the atomic time.
 - 3. Ability to acquire time signal from government sponsored, atomic clock-based timeservers using computer network with internet access.
 - a. Synchronize other master/secondary clocks using this time signal.
 - b. Synchronize integrated intercom/school safety system using this time signal.
 - 4. The Atomic Clock Synchronized Controller Unit shall provide a Universal Serial Bus port for the connection of on-site diagnostics by distributor or factory-trained personnel.
 - 5. Provide interface equipment as required for seamless integration of wireless clock to intercom system.

2.12 INTERCONNECTIONS

- A. Fire Alarm System:
 - 1. Provide relays and sensors as required at the fire alarm system so that the PA system will mute during an alarm initiated from the fire alarm system. Provide an override switch at the main mic and at the rack so that this interface can be overridden in the event an all page is required to inform the occupants.
- B. Remote Sound Systems:
 - 1. Provide relays and sensors at all remote sound systems installed as part of this project. The local sound shall mute when the PA speaker is activated for a page. This shall apply to every space.

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C. Telephone System:

1. Provide interface to the telephone system for full integration so that the classroom phones can communicate with the office over the intercom system. There shall also be an interconnection so that any phone, analog, digital or IP, can initiate a general page.
2. An additional interface between the intercom and telephone system shall be made so that after a code has been presented, the intercom system will sound a tone on incoming phone call. Once the phone is answered, the tone will cease.

D. Security System:

1. Provide all equipment and connections necessary to interface with the security system. Inside and exterior audible alarms shall be accomplished through the Paging/Sound System speakers. Coordinate installation with security system supplier.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All data wiring must meet Division 27 "Communications Cabling," and be fully tested, supported and warrantied as part of the data system.
- B. Comply with installation instructions provided by system manufacturer. Provide type of cables as required.
- C. All wiring shall be plenum rated where required by code.
- D. Install system to comply with drawings and final shop drawings in compliance with manufacturer's printed instructions.
- E. Cable identification: shall be provided on both ends of each cable and termination with the owner's room number and the wiring block or device to which it is connected. Tags shall be permanent and neat.
- F. Furnish and install necessary conduit, raceways, pull boxes, outlet boxes and wire to provide a complete system or systems as herein specified. All wiring shall be tested for continuity and freedom of all grounds and short circuits.
- G. All low voltage cables must be continues run between termination points.
- H. Intercommunications system cable shall not share conduit with any other system.
- I. The Contractor shall use the types of wire recommended by the Sound Equipment Manufacturer. However, the size and quality shall not be less than that previously specified or indicated on the drawings. If cross talk, appreciable loss of volume or distortion occurs after installation has been completed, it shall be the mutual responsibility of the Contractor and Manufacturer to correct any such condition without cost to the owner. The Contractor in no case shall use the type of wire which he merely assumes to be the best. This recommendation shall be from the equipment manufacturer.
- J. Analog Remote Reinforcement Sound System loudspeakers shall be connected to their local amplifiers with minimum 12awg cable when low impedance (4 or 8 ohms) and minimum 16awg cable when high impedance (70-volt line).
- K. The central control console shall be provided with a 10AWG ground wire to earth ground. Conduit ground shall not be acceptable for this purpose.

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- L. Provide a minimum four (4) telephone lines to the main intercommunications rack for telephone integration. Provide additional wiring to perform integrations as listed.
- M. **Contactor shall coordinate all IP addressing with the owner prior to installing any IP based devices, including, but not limited to IP speakers, IP amplifiers, etc.**

3.2 LABELING

- A. **All IP devices, including, but not limited to IP speakers, IP amplifiers, etc. shall be provided with a self-adhesive label identifying the IP address and data jack label. Verify with owner location of label prior to affixing.**
- B. Label all data lines, jacks, patch panels, etc. as directed in Division 27, "Communications Cabling."
- C. Provide additional label at all IP speakers matching jack label.

3.3 DEMONSTRATION

- A. Programming: Review all system programming with the owner's representative and the engineer and obtain written approval before system is put on line. Telephone service interface shall be coordinated with the owner but paid for and performed by this contractor.
- B. Subsequent to hookups of equipment, test the entire system and demonstrate proper functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.
- C. Documentation: Bind the test results and cable identification in a cable record book indexed for easy reference during future maintenance operations. Turn book over to the owner's authorized representative upon completion of commissioning.
- D. All remote sound reinforcement systems shall be tuned by a qualified technician. The technician shall provide printed documentation of all system settings and raw and final system equalization settings as determined by real time analyzer from a minimum of 3 averaged locations in each space. Provide reports in close-out documentation.

3.4 TRAINING

- A. Upon completion of installation, arrange in service training of the system operation for personnel designated by the owner. Provide a minimum of two, four (4) hour training sessions. Notify in writing through the Electrical Contractor, the Architect, and the Owner of the time and date the first demonstration will take place. Conduct a walking tour of the system.
- B. Provide training on how to program the system using the master telephone and through the computer interface to the system.
- C. Six (6) to twelve (12) months from substantial completion, provide an additional minimum four (4) hour on-site training session with the owner to review the system with owner designated personnel. During this training, provide additional programming services as required/requested.

END OF SECTION 27 51 23