ADDITIONS AND ALTERATIONS
QUAKER VALLEY MIDDLE SCHOOL
Borough of Sewickley, Allegheny County, Pennsylvania
Eckles Project No. 09052.300

QUAKER VALLEY SCHOOL DISTRICT
Sewickley, PA

General Construction (GC) Contract 09052.300-01
HVAC Construction (HC) Contract 09052.300-02
Plumbing/Fire Suppression Construction (PC) Contract 09052.300-03
Electrical Construction (EC) Contract 09052.300-04
Technology/Communications Construction (TCC) Contract 09052.300-05
Food Service Equipment Construction (FSEC) Contract 09052.300-06
Architectural Casework Construction (ACC) Contract 09052.300-07
Landscaping Construction (LC) Contract 09052.300-08

RE-BID SET
6 June 2011
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SECTION 33 4100  STORM DRAINAGE UTILITIES

END OF DOCUMENT
SECTION 23 6000 - DIRECT DIGITAL CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General, Supplementary, Special Conditions, and Division 01 - General Requirements, apply to work specified in this section and the other sections of Division 26 and 28. BAS subcontractor must familiarize himself with the terms of the above documents.

B. Prevailing Wage Requirement: This project requires the BAS subcontractor to adhere to the Pennsylvania Prevailing Wage Act. The BAS subcontractor shall be required to submit weekly certified payroll for all on site labor including installation, deliveries, programming, calibration, commissioning, start-up, graphic design and training.

C. Requirements of the following Division 26 and 28 Sections apply to this section:
   1. 26 0923 Lighting Control Devices
   2. 26 1900 Digital, Addressable Fire Alarm System

1.2 RELATED WORK

A. Common Work Results for HVAC

B. Testing, Adjusting, and Balancing for HVAC

C. Low Voltage Switching

1.3 GENERAL SCOPE OF WORK

A. The Quaker Valley School District has instituted an open protocol district wide integrated facility management system of control for all their HVAC and Security functions. The districts Web-Base facility management system utilizes the standard ANSI/ASHRAE Native BACnet open protocol, a data communication protocol for building automation and control networks per the ASHRAE Standard 135-2004/2008. The BACnet operating software resides on the two district servers located at the Quaker Valley Middle School. From the District’s Host Operators Workstation or from any Web Enabled PC, authorized users may control and monitor all the of the HVAC and Security functions of the Edgeworth Elementary School, Osborne Elementary School, Quaker Valley High School, and the Sewickley Valley Public Library. It is the school districts intent to keep this existing system intact, and for all new systems of control to be have similar capabilities.

B. The Contractor shall furnish and install a complete, web based, native BACnet HVAC building automation system (BAS) including all necessary hardware, all operating and applications software necessary to perform the control sequences of operation, and lighting control functions as called for in this specification or as shown on the drawings. The new system shall be a web base native BACnet system per ASHRAE standard 135-2004/2008.
C. The Contractor shall have reviewed all drawings and contract documents and obtained information as necessary prior to submittal of the bid to ensure that prevailing physical conditions and project arrangements that may be material to the performance of the work have been ascertained and accommodated in the bid. No claims for additional payments will be accepted due to the Contractor’s failure to complete this review process.

D. The system shall include and incorporate the following building subsystems into a single-seat, fully integrated automation system:
   1. HVAC Control and Monitoring
   2. Web Enabled Access
   3. Lighting Control
   4. Fire Alarm Monitoring

E. All HVAC automation components of the system – workstations, application controllers, unitary controllers, etc. shall communicate using the native BACnet protocol, as defined by ASHRAE Standard 135-2004/2008. No gateways shall be used for communication to HVAC controllers furnished under this section. At a minimum, provide controls for the following:
   1. Rooftop units
   2. Fan Coil
   3. Heat Recovery Units
   4. Exhaust and supply fans
   5. High Efficiency Gas Boilers including hot water pumps
   6. Package Air Cooled Chiller and Chilled Water Pumps
   7. Make Up Air Units
   8. Variable Air Volume and Fan Powered Box control.
   9. Cabinet and unit heater controls
   10. Monitoring points for packaged equipment
   11. Power wiring to DDC devices and BAS panels

F. All lighting control panels shall be furnished and installed as specified in division 16 by E.C. and shall be BACnet compliant. The BAS subcontractor shall provide the required integration to provide the desired zone lighting control and monitoring of the new systems.

G. The Fire Alarm system is not included in this division; however, provide zone-by-zone annunciation of fire alarms, using the BACnet communications protocol. Fire alarm panel provided by Division 26 Electrical Contractor shall also provide BACnet interface protocol card.

H. The furnished DDC system shall be backwards compatible in order to prevent system obsolescence.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products and integrated HVAC/Security system specified in this Section with minimum 10 years documented experience.

B. BAS subcontractor: Installation by personnel directly employed by the proposed manufacturer or by personnel of a company that is a fully authorized licensed representative of the
manufacturer with a minimum of five years of successfully installed and maintained BAS projects.

C. Customer support service: BAS subcontractor shall maintain a 24 hour 7 day per week manned answering service, technicians trained on the DDC HVAC controls and the security equipment specified and furnished. BAS subcontractor shall maintain an in house inventory of DDC and security related replacement parts.

D. All DDC control equipment, software, web browser, access controllers, shall be the product of one manufacturer.

1.5 DESCRIPTION OF WORK

A. Except as otherwise noted, the Building Automation System shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.

B. The BAS subcontractor shall review and study all drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, etc., to be provided.

C. This Section shall coordinate and supervise the installation of pressure taps, flow meters, piping wells, valves, automatic dampers, air flow measuring devices and all devices furnished by this Section. Installation of automatic control dampers and air flow measuring station, installation of wells, flow meters and automatic valves shall be by the HVAC Contractor.

D. All interlocking, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS subcontractor and representatives of the Owner will review and check out the system. At that time, the BAS subcontractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

E. Andover will tie into the existing district wide system. Other control companies will supply a two way full BACnet stand-alone ATC system and will not be required to tie into the existing Andover system. However, systems other than Andover will be required to furnish at least one Operator Workstation, one portable “laptop” computer suitable for field access to controllers and Digital ATC devices, and Web access for at least 2 simultaneous users.

F. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Electrical Contractor, Security Contractor, balancing agency, and Owner’s representative.

1.6 WORK BY OTHERS
A. The BAS subcontractor shall cooperate with other Contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each Contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others’ work.

B. The HVAC Contractor shall install all control valves, sensor wells, flow meters, flow measuring stations and other similar equipment provided by the BAS subcontractor. BAS subcontractor shall be responsible to coordinate the location of the equipment provided by the BAS subcontractor with the HVAC Contractor.

C. The Electrical Contractor shall provide:
   1. All power wiring to motors, heat trace, junction boxes for power to BAS and security panels.
   2. Provide and wire duct mounted smoke detectors to the building fire alarm system. HVAC Contractor to mount these devices. BAS subcontractor to hardwire to fan shut down.
   3. All power wiring to all smoke damper actuators for smoke control sequence.
   4. All power wiring to all lighting circuits.

1.7 APPROVED SYSTEM SUBCONTRACTORS AND MANUFACTURERS

A. The following are the approved BAS Manufacturers:
   1. Schneider Electric Andover Controls
   2. Siemens
   3. Johnson Controls
   4. Kreuter

B. The following are the approved BAS subcontractors:
   1. Andover: Combustion Service and Equipment
   2. Johnson Controls: Pittsburgh Branch Office
   3. Siemens: Pittsburgh Branch Office
   4. Kreuter: Building Control Systems

C. The BAS subcontractor shall have an office that offers complete maintenance and support services on a 24-hour, 365 day/year basis. This office shall have direct access to or inventory of spare parts and all necessary test and diagnostic equipment required to install, commission, and service the BAS provided.

D. The BAS architectures shall consist of the products of manufacturers regularly engaged in the production of technology systems and shall be these manufacturer’s latest standard of design and release for these products at the time of bid.

E. The software and firmware on the network shall be updated at the latest currently available manufacturer’s revision at the start of Warranty and if selected during the 2-year Service Contract agreement.

F. The above list of manufacturers applies to operator workstation software, controller software, the custom application programming language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein or example, sensors, valves, dampers, and actuators, do not need to be manufactured by the above manufacturers.
1.8 CODES AND STANDARDS

A. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids of the following codes:
1. National Electric Code (NEC)
2. International Building Code
3. International Mechanical Code
4. Local amendments to the above codes.

B. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

C. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.

D. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.

E. All smoke dampers shall be rated in accordance with UL 555S.

F. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

G. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.9 SYSTEM PERFORMANCE

A. Performance Standards. The integrated system shall conform to the following:
1. Graphic Display. The system shall display a graphic with 20 dynamic points with all current data within 10 seconds.
2. Graphic Refresh. The system shall update a graphic with 20 dynamic points with all current data within 8 seconds.
3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.
4. Object Scan. All changes of state and change of analog values will be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will have been current within the previous 60 seconds.
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 10 seconds. When the alarm is dialed out by modem, this value shall not exceed 20 seconds.
6. Access Event Response Time. The maximum time from when a card reader sees a valid or invalid card read to when it is annunciated at the workstation shall not exceed 10 seconds.
7. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The BAS subcontractor shall be responsible for selecting execution times consistent with the mechanical process under control.

8. Performance. Programmable HVAC controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

9. Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5 seconds of each other.

10. Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed in Table 1.

11. Stability of Control. Control loops shall maintain measured variable at set point within the tolerances listed in Table 2.
Table 1: Reporting Accuracy

<table>
<thead>
<tr>
<th>Measured Variable</th>
<th>Reported Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Temperature</td>
<td>±0.5°C [±1°F]</td>
</tr>
<tr>
<td>Ducted Air</td>
<td>±0.5°C [±1°F]</td>
</tr>
<tr>
<td>Outside Air</td>
<td>±1.0°C [±2°F]</td>
</tr>
<tr>
<td>Dew Point</td>
<td>±1.5°C [±3°F]</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>±0.5°C [±1°F]</td>
</tr>
<tr>
<td>Delta-T (water and/or air)</td>
<td>±0.15°C[±0.25°F]</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>±5% RH</td>
</tr>
<tr>
<td>Water Flow</td>
<td>±5% of full scale</td>
</tr>
<tr>
<td>Airflow (terminal)</td>
<td>±10% of full scale (see Note 1)</td>
</tr>
<tr>
<td>Airflow (measuring stations)</td>
<td>±5% of full scale</td>
</tr>
<tr>
<td>Airflow (pressurized spaces)</td>
<td>±3% of full scale</td>
</tr>
<tr>
<td>Air Pressure (ducts)</td>
<td>±25 Pa [±0.1 &quot;W.G.&quot;]</td>
</tr>
<tr>
<td>Air Pressure (space)</td>
<td>±3 Pa [±0.01 &quot;W.G.&quot;]</td>
</tr>
<tr>
<td>Water Pressure</td>
<td>±2% of full scale (see Note 2)</td>
</tr>
<tr>
<td>Electrical (A, V, W, Power factor)</td>
<td>5% of reading (see Note 3)</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>±5% of reading</td>
</tr>
<tr>
<td>Carbon Dioxide (CO2)</td>
<td>±50 ppm</td>
</tr>
</tbody>
</table>

Note 1: 10%-100% of scale
Note 2: For both absolute and differential pressure
Note 3: Not including utility-supplied meters

Table 2: Control Stability and Accuracy

<table>
<thead>
<tr>
<th>Controlled Variable</th>
<th>Control Accuracy</th>
<th>Range of Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Pressure</td>
<td>±50 Pa [±0.2&quot; w.g.]</td>
<td>0-1.5 kPa [0-6&quot; w.g.]</td>
</tr>
<tr>
<td></td>
<td>±3 Pa [±0.01&quot; w.g.]</td>
<td>-25 to 25 Pa [-0.1 to 0.1&quot; w.g.]</td>
</tr>
<tr>
<td>Airflow</td>
<td>±10% of full scale</td>
<td></td>
</tr>
<tr>
<td>Space Temperature</td>
<td>±1.0°C [±2.0°F]</td>
<td></td>
</tr>
<tr>
<td>Duct Temperature</td>
<td>±1.5°C [±3.0°F]</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>±5% RH</td>
<td></td>
</tr>
<tr>
<td>Fluid Pressure</td>
<td>±10 kPa [±1.5 psi]</td>
<td>0-1 MPa [1-150 psi]</td>
</tr>
<tr>
<td></td>
<td>±250 Pa [±1.0&quot; w.g.]</td>
<td>0-12.5 kPa [0-50&quot;w.g.]</td>
</tr>
<tr>
<td></td>
<td>differential</td>
<td></td>
</tr>
</tbody>
</table>

1.10 SUBMITTALS

A. BAS subcontractor shall provide shop drawings or other submittals on all hardware, software, and installation to be provided. No work may begin on any segment of this project until submittals have been reviewed and approved for conformity with the design intent.
B. All shop drawings shall be prepared in Visio Professional or AutoCAD 2000 or higher software. In addition to the drawings, the BAS subcontractor shall furnish a CD containing the identical information. Drawings shall be size C or larger.

C. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller.Typicals will be allowed where appropriate.

D. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. BAS subcontractor must provide manufacturer’s Protocol Implementation Conformance Statement (PICS) for workstation software and for all applicable devices in compliance with BACnet standards.

E. Control damper schedule including a separate line for each damper and a column for each of the damper attributes including: code number, fail position, damper type, damper operator, blade type, bearing type, seals, duct size, damper size, mounting and actuator type.

F. Control valve schedules including a separate line for each valve and a column for each of the valve attributes: code number, configuration, fail position, pipe size, valve size, body configuration, close off pressure, capacity, valve CV, calculated CV, design pressure, actual pressure and actuator type.

G. Room schedule including a separate line for each VAV box and terminal unit indicating minimum/maximum cfm, pickup gain, box area, and bias setting.

H. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements.

I. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs.

J. Submit ten (10) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The BAS subcontractor prior to submitting shall check all documents for accuracy.

K. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.

L. Submittals shall be provided within 8 weeks after all major equipment submittals or shop drawings have been approved.

M. Within one month of contract award, provide a schedule of the work indicating the following:
1. Intended sequence of work items.
2. Start dates of individual work items.
3. Duration of individual work items.
4. Planned delivery dates for major material and equipment, and expected lead times.
5. Milestones indicating possible restraints on work by other trades or situations.

N. Provide monthly written status reports indicating work completed, revisions to expected delivery dates, etc. An updated project schedule shall be included.

1.11 PROJECT RECORD DOCUMENTS

A. Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and shall include:

1. Project Record Drawings. These shall be as-built versions of the submittal shop drawings. One set of CD ROM media including CAD or Visio drawing files also shall be provided.
2. Testing and Commissioning Reports and Checklists. Completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3: “Control System Demonstration and Acceptance.”
3. Operation and Maintenance (O & M) Manual. This shall include as-built versions of the submittal product data. In addition to the information required for submittals, the O & M manual shall include:

   a. Names, addresses, and 24-hour telephone numbers of contractors installing equipment, and the control systems and service representatives of each.
   b. Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables. One set of Programming Manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
   c. Engineering, Installation, and Maintenance Manual(s) that explain how to design and install new points, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
   d. A listing and documentation of all custom software created using the programming language, including the set points, tuning parameters, and object database. One set of magnetic/optical media containing files of the software and database also shall be provided.
   e. One set of magnetic/optical media containing files of all color graphic screens created for the project.
   f. A list of recommended spare parts with part numbers and suppliers.
   g. Complete original issue documentation, installation, and maintenance information for all third-party hardware provided, including computer equipment and sensors.
   h. Complete original issue diskettes for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
   i. Licenses, guarantee, and warranty documents for all equipment and systems.
1.12 TRAINING

A. The BAS subcontractor shall provide both on-site and classroom training to the Owner’s representative and maintenance personnel per the following description:

1. On-site training shall consist of a minimum of (40) hours of hands-on instruction geared at the operation and maintenance of the installed systems. The curriculum shall include

   a. System Overview
   b. System Software and Operation

      1) System access
      2) Software features overview
      3) Changing set-points and other attributes
      4) Adding and editing personnel records
      5) Alarm operation
      6) Scheduling
      7) Editing programmed variables
      8) Displaying color graphics
      9) Running reports
     10) Workstation maintenance
     11) Application programming
     12) Access control programming
     13) Video photo imaging

c. Operational sequences including start-up, shutdown, adjusting and balancing.

d. Equipment maintenance.

B. The training shall be "hands-on" type and shall take place at the Middle School or a location designated by the Owner. The training class will use the actual Operation and Maintenance manual that will be submitted for this project.

C. Provide a complete set of DDC operating manuals, programming manuals, maintenance manuals and back up CD/Software used to set up and program the DDC system. School District, upon receipt of this information, shall sign the required software licensing agreement.

D. BAS subcontractor shall video tape the training sessions and provide this to the Owner at the completion of each session.

1.13 WARRANTY

A. The BAS subcontractor shall warrant the system for 12 months after system acceptance and beneficial use by the owner. Successful completion or the performance test for a system shall be considered mandatory for owner acceptance. During the warranty period, the BAS subcontractor shall be responsible for all necessary revisions to the software as required to provide a complete and workable system consistent with the letter and intent of the Sequence of Operation section of the specification.
B. The BAS subcontractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours. 4-hour service response is required for all emergency service calls.

C. Updates to the manufacturer’s software shall be provided at no charge during the warranty period.

D. During the 1st year warranty, the BAS subcontractor is required to provide the 48 hours of preventative maintenance as outlined in Section 1.10 Extended Service Contract.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. The web-based Building Automation System (BAS) shall encompass the HVAC control system, lighting control system, and fire alarm monitoring. The BAS shall be controlled through a single graphical, web-based operator interface that allows for instant access to any sub-system through a standard browser.

B. The Owner shall provide all required, ISDN lines and Internet Service Provider services, IP drops and IP address as required, and connections as necessary for the BAS subcontractor to complete the work as contracted at the Owner’s direct cost. The BAS subcontractor shall identify the specific requirements in a shop drawing submittal.

C. HVAC Control – The BAS workstation and HVAC controllers shall be designed in strict accordance with ASHRAE’s BACnet standard, 135-2004/2008, to provide interoperability between different building subsystems. The system shall use BACnet network types and protocols exclusively. Non-BACnet-based systems are not acceptable. The BAS subcontractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability. BAS subcontractor must provide manufacturer’s Protocol Implementation Conformance Statement (PICS) for workstation software and every controller model that are installed.

D. Lighting Control – The BAS subcontractor shall interface with the lighting panel furnished by division 26. Lighting panel shall be furnished with a BACnet communication card to provide seamless integration and control as indicated on the Electrical Drawings, Lighting panels shall be controlled through the BAS graphical workstation environment, with manual override, scheduled on/off, and occupancy sensor control.

E. Smoke Detection – When a fire alarm or early warning smoke detection alarm is triggered, the system shall perform all necessary fan shutdown procedures as appropriate for the site.

F. For this project the system shall consist of the following top-level components:

1. Administration and Programming Workstation(s).
   a. The BAS subcontractor shall furnish one Integrated Operating Workstation (OW) Computer and printer as described below. The workstations must be running the standard workstation software developed and tested by the manufacturer of the network controllers and the standalone controllers. No third party front-end
workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile. The workstations must communicate to the Network Controllers through Ethernet 10/100 mbps. Workstations that communicate using RS232 or RS 485/422 are unacceptable.

2. Web-Based Operator Workstations
   a. The BAS subcontractor shall furnish licenses for 2 concurrent users to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. If required, a central web server shall be provided to manage the web-based users. The web-based interface must conform to the B-OWS BACnet device profile.

3. Ethernet-based HVAC Network Router and/or Controller(s).
   a. The BAS subcontractor shall furnish Ethernet-based HVAC network controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet, using the BACnet/IP protocol at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Controllers shall conform to BACnet device profile B-AAC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted.
   b. HVAC Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).

4. Standalone Digital Control Units (SDCUs)
   a. Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each SDCU shall conform to the BACnet device profile B-AAC.
   b. SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).

5. Standalone Lighting Controllers
   a. Provide the necessary quantity and types of lighting controllers to meet the requirements of the project for control of lighting fixtures as indicated on the plans. Each lighting controller will operate completely standalone, containing all of the I/O and programs to control its associated lighting circuits. Lighting controllers shall communicate either through the BACnet MS/TP field bus, or through an Ethernet connection using BACnet/IP.

2.2 SYSTEM ARCHITECTURE

A. General – The Building Automation System (BAS) shall consist of a two-tiered system, an upper-level Ethernet TCP/IP network, and a twisted-pair field bus based on BACnet MS/TP. All field bus communications must be routed through Ethernet-based Network Controllers or Routers, and not directly through PC workstations or servers. The BAS subcontractor shall provide all communications media, connectors, repeaters, hubs and routers necessary for a complete system.
B. The system shall include Administration and Programming Workstations (APWs), Web-based Operator Workstations (WOWs), and one File Server to support system configurations where more than three operator workstations are required. The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable, using a single MS-SQL database.

C. Level 1 Network Description: Level 1, the main backbone of the system, shall be an Ethernet 10/100bT LAN/WAN, using BACnet/IP as the communications protocol. Network Router/Controllers, Operator Workstations, and the Central File Server shall connect directly to this network without the need for Gateway devices. Up to 1,000,000 devices (workstations, controllers, etc.) can be connected to this backbone.

D. Level 2 Network Description: Level 2 of the system shall consist of one or more BACnet MS/TP field buses managed by the Network Router/Controllers. Minimum speed shall be 76.8kbps. The Level 2 field bus consists of an RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC equipment and lighting.

E. Dial-Up (RAS) Connectivity: The BAS shall also be capable of managing remote systems via standard dial-up phone lines as a standard component of the software. Front-end “add-on” software modules to perform remote site communication will not be allowed.

F. Communication services over the network shall result in operator interface and value passing that is transparent to the network architecture as follows:
   1. Connection of an operator interface device to any one controller on the network will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the network.
   2. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the network. This value passing shall be automatically performed by a controller when a reference to a object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform network value passing.

G. The time clocks in all controllers shall be automatically synchronized daily via the network. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the network.

H. BAS LAN Segmentation: The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single SQL file server. This enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database – with no need for a separate file server.

I. Standard Network Support: All NRCs, Workstation(s) and File Server shall be capable of residing directly on the owner’s Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NRC’s, Workstation(s) and File Server shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new
enterprise network or structured cabling system. This also allows the option of the maintenance
of the LAN/WAN to be performed by the owner’s Information Systems Department as all
devices utilize standard TCP/IP components.

J. System Expansion: The BAS system shall be scalable and expandable at all levels of the system
using the same software interface, and the same Level 1 and Level 2 controllers. Systems that
require replacement of either the workstation software or field controllers in order to expand the
system shall not be acceptable.

K. Additional web-based operator licenses shall have the ability to be added in the field through an
upgrade of the web server’s security key, with no re-programming required.

L. The system shall use the same application programming language for all levels: Operator
Workstation, Network Router/Controller, and Standalone Digital Control Unit. Furthermore,
this single programming language shall be used for all applications: environmental control,
lighting control, and digital data communication interfaces to third party microprocessor-based
devices.

M. Support for Open Systems Protocols: All HVAC hardware and software included under this
section shall conform to ASHRAE standard 135-2004/2008, to promote interoperability
between building subsystems. Additionally, the BAS design must include solutions for the
integration of the following “open systems” protocols: LonTalk, Modbus, and digital data
communication to third party microprocessors such as chiller controllers, fire panels and
variable frequency drives (VFDs).

N. The system shall also provide the ability to program custom ASCII communication drivers that
will reside in a BACnet Gateway, for communication to third party systems and devices. These
drivers will provide real time monitoring and control of the third party systems. Once
programmed, these data points shall be monitored and controlled in exactly the same manner as
native BAS data points.

2.3 OPERATOR WORKSTATION REQUIREMENTS

A. General - BAS subcontractor

1. The programming and configuration workstation software shall be configurable as either a
single workstation system (with a local database) or multi-workstation system where the
database is located on a central file server. The client software on multi-workstation
system shall access the file server database program via an Ethernet TCP/IP network
running at 100MBPS.

2. The web-based user interface software must be capable of expansion up to 25 concurrent
users.

3. All workstation software, both programming and software and web-based operator
software, shall conform to the BACnet B-OWS device profile, using BACnet/IP to
communicate to other BACnet devices. The software shall be designed so that each user
of the software can have a unique username and password. This username/password
combination shall be linked to a set of capabilities within the software, set by, and only
editable by, a system administrator. These sets of capabilities shall range from view only,
acknowledge alarms, enable/disable, change values, program, and administrate. The
system shall allow the above capabilities to be applied independently to each class of
object. The system shall allow an unlimited number of users to be configured per
workstation. The SMS shall allow the system administrator to configure each workstation with those functions that may be performed at that workstation Individual user passwords shall also further restrict user functions and shall be specific to each user.

4. All configuration workstations shall be Pentium 4-based personal computers operating under the Microsoft Windows XP operating system. The application software shall be capable of communication to all Network Router/Controllers and Standalone Digital Control Units, feature high-resolution color graphics, alarming, reporting, and be user configurable for all data collection and data presentation functions.

5. For multi-workstation systems, a minimum of 256 workstations shall be allowed on the Ethernet network along with the central file server. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations without the requirement for manual copying of files. Multi-workstation systems with no central database will not be acceptable. Multi-workstation systems with distributed/tiered file servers and a central (master) database will be acceptable.

B. Administration/Programming Workstation Minimum Hardware Requirements (Single workstation or multi-workstation configuration).

1. The workstation shall meet or exceed the following criteria:
   a. 3 GHz Pentium 4 processor (1 GH MHz)
   b. 1 GB of RAM
   c. Microsoft Windows 7 - 32 bit operating system
   d. Serial port, parallel port, USB port
   e. 10/100MBPS Ethernet NIC
   f. 180 GB hard disk
   g. CD-RW drive
   h. SVGA Compatible, 20” LCD monitor
   i. Two Video High Resolution Cards
   j. Optical mouse and full function keyboard
   k. Audio sound card and speakers
   l. License agreement for all applicable software.

C. File Server Hardware Minimum Requirements.
   1. Software shall include MICROSOFT SQL Server Software XP/2003 server operating system
   2. License agreement for all application software
   3. BAS Server/Workstation shall be Dell

D. Schedule of operator Workstations (OWS)

1. OWS-1
   a. PC Type: Desktop
   b. Monitor Style: Flat Panel (LCD)
   c. Monitor Size: 22 inch
   d. Monitor Location: Desk Function/Control: (HVAC) (Security) (CCTV) (Lighting) (Internal School Use)

E. Large Screen Flat Panel LCD Monitor

1. Pelco Model PMCL422A LCD Monitor or Approved Equal
a. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer’s system.
b. All systems and components shall have been thoroughly tested and proven in actual use.
c. All systems and components shall be provided with the availability of a toll-free (U.S. and Canada), 24-hour technical assistance program (TAP) from the manufacturer. The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the products is installed.
d. All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and non warranty items.

2. Flat Panel, LCD Monitor
   a. The flat panel LCD monitor shall have performance-enhancing features such as VGA and DVI (digital visual interface) inputs, PIP (picture-in-picture), looping BNC output, HD resolution, and compatibility with Pelco multiviewers.
   b. The flat panel LCD monitor shall provide a front panel that allows the user to adjust image quality, brightness, size, position, and geometry for optimal viewing.
   c. The flat panel LCD monitor shall meet or exceed the following design and performance specifications.

3. Electrical Specifications
   a. Input Voltage 100-240 VAC, 50/60 Hz
   b. Power Consumption 220 W
   c. Video Input Interfaces 2, BNC, looping, 1, S-Video; looping; 1 RGB; DVI; 1, component
   d. Audio Input Interfaces 2, audio L/R, RCA jack
   e. Horizontal Frequency; 31 kHz to 69 kHz
   f. Vertical Frequency 56 Hz to 85 Hz
   g. Sync Format NTSC/PAL

4. Environmental Specifications
   a. Operating Temperature 32° to 104°F (0° to 40°C)
   b. Operating Humidity 20% to 80%, noncondensing

5. Physical Specifications
   a. Dimensions (with stand)11.9” D x 41.9” W x 28.7” H (72.8 x 30.2 x 106.3 cm)
   b. Unit Weight 72.5 lb. (32.9 kg)

6. Mechanical Specifications
   a. Native Resolution 1366 x 768 WXGA
   b. Panel Aspect Ratio 16:9
   c. Viewing Area
   d. Pixel Pitch 0.681 x 0.681 mm
   e. Video Formats 480i, 4801p, 576i, 576p, 720p, 1080i
   f. Brightness 500 cd/m²
   g. Contrast Ratio 550:1
   h. Backlight Type 20 CCFL
   i. Panel Life 50,000 hours
   j. Viewing Angle (H/V) 170°/178°
k. Displayable Colors  16.7 million
l. Response Time  8 ms
m. PIP(Picture-In-Picture)  Selectable, sizeable, swappable, moveable
n. POP(Picture-On-Picture)Swappable
o. Speakers  Optional, 2 external
p. Front Panel Controls  Power, input/enter, menu/exit up, down, volume -, and volume +
q. Indicators  LED (power on/off)

7. Certifications
   a. TUV Listed
   b. FCC, Class A
   c. CE, Class A
   d. C-Tick

F. Modem – Provide one Windows XP-compatible 56 Kbaud modem for dial-in diagnostics.

G. Printer – Provide an alarm printer and a separate report/graphics printer. The alarm printer shall be an Epson Inkjet or equivalent and the report printer shall be a black-and-white HP LaserJet.

2.4 ADMINISTRATION AND PROGRAMMING WORKSTATION SOFTWARE

A. General Description
   1. The software architecture shall be object-oriented in design, a true 32-bit application suite utilizing Microsoft’s .NET technology, making it easy to fully utilize the power of the operating system to share, among applications (and therefore to the users of those applications), the wealth of data available from the BAS.
   2. The workstation functions shall include monitoring and programming of all controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
   3. Programming of controllers shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

B. System database
   1. The files server database engine must be Microsoft SQL Server. This ODBC (Open Database Connectivity)-compliant database engine allows for an owner to write custom applications and/or reports which communicate directly with the database avoiding data transfer routines to update other applications. The system database shall contain all point configurations and programs in each of the controllers that have been assigned to the network. In addition, the database will contain all personnel files and images, workstation files including color graphic, alarm reports, text reports, historical data logs, schedules, and polling records.

C. User Interface
1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user that has logged into the workstation software. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows XP user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

D. User Security

1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. There shall be an inactivity timer adjustable in software that automatically logs off the current operator after the timer has expired. Provide automatic password aging. If enabled, each user will be forced to change his or her password after a specified time period. Also provide a system-wide, adjustable minimum password length.

E. Database Partitioning

1. Since the BAS combines many disciplines, the system must be able to logically partition its database by function, and must be able to limit each user’s privileges to a certain partition. For example, security guards must have access to the alarm viewer and graphics interface; they may not have access to HVAC objects, lighting objects, or the programming environment. HVAC users may have access to all HVAC graphics and setpoints, but may not have access to personnel records, doors, or access areas. This type of partitioning must be easy and intuitive to set up and administer.

F. Configuration Interface

1. The workstation software shall use a familiar Windows Explorer-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, personnel record, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.

2. The configuration interface shall also include support for template objects. These template objects shall be used as building blocks for the creation of the BAS database. The types of template objects supported shall include all data point types (input, output, setpoints, etc.), alarm algorithms, alarm notification objects, reports, graphics displays, schedules, personnel records and programs. Groups of template object types shall be able to be set up
as template subsystems and systems. The template system shall prompt for data entry if necessary. The template system shall maintain a link to all “child” objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants to update all of the child objects with the change. This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the BAS.

2.5 COLOR GRAPHIC DISPLAYS

A. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:

1. XGA, bit-mapped displays. The user shall have the ability to import AutoCAD generated picture files as background displays.
2. A built-in library of animated objects such as doors, fire alarms, dampers, fans, pumps, buttons, knobs, gauges, and graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels. Using the mouse, operators shall be able to adjust setpoints, unlock doors, start or stop equipment, modify PID loop parameters, or change schedules.
3. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
4. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
5. If separate, provide a copy of the full graphic editing software on each workstation.
6. Provide the ability to link to any video camera on the system by clicking on a camera icon on a graphical floor plan. When selected, live video from that camera will display immediately.

B. The system shall support an operator definable “default” system page. The default system page shall be displayed upon system startup, operator activity time-outs, and when the system is not in use. This default system page may be any one of the standard dynamic graphic pages or may be a custom display developed for this purpose. The operator shall be able to display their corporate logo, emergency information, an index of all graphic pages, etc. as the default system page.

C. BAS subcontractor shall build the following graphics screens, complete with all pertinent graphics points:

1. Digitized view of building with icons for each sub heading.
2. Time and event programming (showing floor plan with each area as different color).
3. Central equipment
   a. Hot water system including boiler, hot water pumps, VFDs, and 3-way valve.
   b. Chilled water system including chiller, chilled water pumps.
   c. Rooftop units
   d. Heat Recovery Units
e. VAV & FP Boxes  
f. Fan Coils  
g. Exhaust fans  
h. Misc. equipment (as required)  
4. Room data (floor plan)  
a. Click on floor plan to bring up any room. Room plans shall show all the rooms  
parameters. For a typical room shall be graphic showing a Fan Coil, VAV box,  
Etc. with all its working parameters such as damper position, inlet air temperature,  
valve position, actual CFM, room set point, space temperature, CFM set point, and  
fan control. Each room will be required to have its own graphic page.

2.6 ALARM MANAGEMENT  
A. The software shall be capable of accepting alarms directly from controllers, or generating  
alarms based on evaluation of data in controllers and comparing to limits or conditional  
equations configured through the software. Any alarm (regardless of its origination) will be  
integrated into the overall alarm management system and will appear in all standard alarm  
reports, be available for operator acknowledgment, and have the option for displaying graphics,  
or reports.

B. Alarm management features shall include:

1. A minimum of 255 alarm notification levels. Each notification level will establish a  
unique set of parameters for controlling alarm display, acknowledgment, keyboard  
annunciation, alarm printout and record keeping.
2. Automatic logging in the database of the alarm message, point name, point value,  
connected controller, timestamp, username and time of acknowledgement, username and  
time of alarm silence (soft acknowledgement)
3. Automatic printing of the alarm information or alarm report to an alarm printer or report  
printer.
4. Playing an audible beep or audio (wav) file on alarm initiation or return to normal.
5. Automatically displaying live video from up to 4 associated cameras for the specific  
alarm. For this project, pop-up video shall be configured for each forced door alarm, door  
ajar alarm, and fire alarm in the system.
6. Sending an email or alphanumeric page to anyone listed in a workstation’s email account  
address list on either the initial occurrence of an alarm and/or if the alarm is repeated  
because an operator has not acknowledged the alarm within a user-configurable  
timeframe. The ability to utilize email and alphanumeric paging of alarms shall be a  
standard feature of the software integrated with the operating system’s mail application  
interface (MAPI). No special software interfaces shall be required.
7. Individual alarms shall be able to be re-routed to a workstation or workstations at user-  
specified times and dates. For example, a critical high temp alarm can be configured to be  
routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri)  
and to a Central Alarming workstation at all other times.
8. An active alarm viewer shall be included which can be customized for each user or user  
type to hide or display any alarm attributes.
9. The font type and color, and background color for each alarm notification level as seen in  
the active alarm viewer shall be customizable to allow easy identification of certain alarm  
types or alarm states.
10. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

2.7 CUSTOM REPORT GENERATION

A. The software will contain a built-in custom report generator, featuring word processing tools for the creation of custom reports. These custom reports shall be able to be set up to automatically run or be generated on demand. Each workstation shall be able to associate reports with any word processing or spreadsheet program loaded on the machine. When the report is displayed, it will automatically spawn the associated report editor such as MS Word.

1. Reports can be of any length and contain any point attributes from any controller on the network.
2. The report generator will have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.
3. It shall be possible to run other executable programs whenever a report is initiated.
4. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
5. Standard reports shall include:
   a. Points in each controller.
   b. Points in alarm
   c. Disabled points
   d. Overridden points
   e. Operator activity report
   f. Alarm history log.
   g. Program listing by controller with status.
   h. Network status of each controller

2.8 SPREADSHEET-STYLE REPORTS

A. The software shall allow the simple configuration of row/column (spreadsheet-style) reports on any class of object in the system. These reports shall be user-configurable and shall be able to extract live (controller) data and/or data from the database. The user shall be able to set up each report to display in any text font, color and background color. In addition the report shall be able to be configured to filter data, sort data and highlight data which meets user-defined criteria.

2.9 HTML REPORTING

A. The above spreadsheet-style reports shall be able to be run to an HTML template file. This feature will create an HTML “results” file in the directory of the HTML template. This directory can be shared with other computer users, which will allow those users with access to the directory to “point” their web browser at the file and view the report.
2.10 SCHEDULING

A. It shall be possible to configure and download from the workstation schedules for any of the controllers on the network.

1. Time of day schedules shall be in a calendar style and shall be programmable for a minimum of one year in advance. Each standard day of the week and user-defined day types shall be able to be associated with a color so that when the schedule is viewed it is very easy, at-a-glance, to determine the schedule for a particular day even from the yearly view. To change the schedule for a particular day, a user shall simply click on the day and then click on the day type.

2. Each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.

3. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.

2.11 PROGRAMMER’S ENVIRONMENT

A. The programmer's environment will include access to a superset of the same programming language supported in the controllers. Here the programmer will be able to configure application software off-line (if desired) for custom program development, write global control programs, system reports, wide area networking data collection routines, and custom alarm management software. On the same screen as the program editor, the programming environment shall include dockable debug and watch bars for program debugging and viewing updated values and point attributes during programming. In addition a wizard tool shall be available for loading programs from a library file in the program editor.

2.12 SAVING/RELOADING

A. The workstation software shall have an application to save and restore field controller memory files. This application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

2.13 DATA LOGGING

A. The workstation software shall have the capability to easily configure groups of data points with trend logs and display the trend log data. A group of data points shall be created by drag-and-drop method of the points into a folder. The trend log data shall be displayed through a simply menu selection, or from a hot spot on a graphic display. This data shall be able to be saved to file and/or printed.

2.14 AUDIT TRAIL
A. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.

2.15 FAULT TOLERANT FILE SERVER OPERATION

A. The system shall provide the option to provide fault tolerant operation in the event of the loss of the CPU, disk drives, or other hardware required to maintain the operational integrity of the system. Operational integrity includes all user interfaces, monitoring of alarm points and access points, and executing access control functions.

B. The switchover mechanism provided shall be automatic. Should the failure be caused by hardware, then the system shall immediately switch to the Backup computer. Should the system failure be caused by software (instruction or data), the system shall not pass the faulted code to the Backup computer, otherwise the Backup shall fail in the same manner of the Primary computer.

C. Switchover to the Backup computer shall be initiated and effective (complete) in a manner and time frame that precludes the loss of event data, and shall be transparent to the system users, except for an advisory alarm message indicating that the switchover has occurred.

D. When the system fails-over from the Primary to the Backup computer, no alarm or other event shall be lost, and the Backup computer shall take control of all system functions.

E. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

F. The Primary computer shall provide continual indication that the Backup computer is unavailable until such time that the fault has been purged.

2.16 WEB-BASED OPERATOR SOFTWARE

A. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network. Access to the system must be available from a connection over the Internet.

B. Graphic Displays – The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser’s graphics shall support commands to change setpoints, unlock doors, enable/disable equipment and start/stop equipment. The graphic shall also be able to display live video from any camera on the system.

C. Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a copy stored in the system database.
D. Alarm Management – Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user’s password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement.

E. Groups and Schedules – Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.

F. Through the browser interface, operators must be able to change schedules – change start and stop times, and add new times to a schedule.

G. Personnel Management – Through the browser interface, operators must be able to add access control personnel records, delete personnel records, add and remove area privileges, and view the stored image of the person.

H. Video Management – Through the browser interface, operators must be able to view live and recorded video from any digital video recorder on the network. The interface must offer an easy method to select the camera to view, and for recorded video, must offer selections for start and stop time when searching video clips.

I. Access Reports – Through the browser interface, operators must be able to create and view reports of access events and access privileges. Reports must be available based on start and stop time, door, area, and person. Invalid attempts must be color-coded red in the report. Provide hot links to the respective personnel records within the report.

J. History Reports – Through the web browser interface, operators must be able to call up graphical reports of historical values over time such as temperature, humidity and any other logged value in the system. The reporting function must also provide graphical reports for analysis of non-analog information such as the alarm log, event log and activity log – examples are a graph of the top 10 alarmed points over a certain period of time, traffic counts for each door over time, workstation activity displayed per workstation.

K. User Accounts and Audit Trail – The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.

L. All commands and user activity through the browser interface shall be recorded in the system’s activity log, which can be later searched and retrieved by user, date, or both.

2.17 BACNET NETWORK ROUTER/CONTROLLERS (NRCS)

A. General

1. Network Controllers shall combine both network routing functions and control functions into a single unit. NRC’s shall route communications between the BACnet/IP network and the BACnet MS/TP field network. They may also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler. A sufficient number of NRCs shall be supplied to fully meet the requirements of this specification and the attached point list.
2. Each NRC shall be classified as a “native” BACnet device, supporting the BACnet Advanced Application Controller (B-AAC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NRCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).

B. Hardware Specifications

1. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.

2. Communication Ports: Each NRC shall provide communication to both the Workstation(s) and the field buses. An on-board 10/100bT Ethernet port shall be provided, as well as a RS-485 port for communications to a maximum of 127 MS/TP devices. All TCP/IP settings, including IP address, default gateway and subnet mask, shall be stored in non-volatile memory.

3. Local Status Indicator Lamps: Provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each output, provide LED indication of the value of the output (On/Off). For each output module provide an LED which gives a visual indication of whether any outputs on the module are manually overridden.

4. Real Time Clock (RTC): Each NRC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. The system shall automatically correct for daylight savings time and leap years and be Year 2000 compliant.

5. Power Supply: The power supply for the NRCs shall be auto sensing, 10-28VDC and 24VAC, 60/50 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered outages. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning.

6. Automatic Restart After Power Failure: Upon restoration of power after an outage, the NRC shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

7. Battery backup: The NRC shall include an on-board lithium battery to back up the controller’s RAM memory. The battery shall have a shelf life of over 10 years, and provide accumulated backup of all RAM and clock functions for at least 3 years. In the case of a power failure, the NRC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NRC shall restart itself from its application program stored in its FLASH memory.

C. Software Specifications

1. General
   a. The NRC shall contain FLASH memory to store both the resident operating system AND the application software. There will be no restrictions placed on the type of application programs in the system. Each NRC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. **User Programming Language:**
   a. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.
   b. Controllers that use a “canned” program method will not be accepted.

D. **Control Software:**

1. The NRC shall have the ability to perform the following pre-tested control algorithms:
   a. Proportional, Integral plus Derivative Control (PID)
   b. Self Tuning PID
   c. Two Position Control
   d. Digital Filter
   e. Ratio Calculator
   f. Equipment Cycling Protection

E. **Mathematical Functions:**

1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

F. **Energy Management Applications:**

1. NRCs shall have the ability to perform any or all of the following energy management routines:
   a. Time of Day Scheduling
   b. Calendar Based Scheduling
   c. Holiday Scheduling
   d. Temporary Schedule Overrides
   e. Optimal Start
   f. Optimal Stop
   g. Night Setback Control
   h. Enthalpy Switchover (Economizer)
   i. Peak Demand Limiting
   j. Temperature Compensated Duty Cycling
   k. CFM Tracking
   l. Heating/Cooling Interlock
   m. Hot/Cold Deck Reset
   n. Free Cooling
   o. Hot Water Reset
G. History Logging:

1. Each controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.

H. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the NRC and can result in the display of one or more alarm messages or reports.
2. Up to 8 alarms can be configured for each point in the controller.
3. Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
4. If communication with the Operator Workstation is temporarily interrupted, the alarm will be time-stamped and buffered in the NRC. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.
5. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

I. Web Server Interface

1. The Network Controller/Router shall include a built-in web server, such that all point values may be viewed and controlled from a standard browser environment. Custom web pages, password-protected, must be able to be stored within the network controller for access by technicians for troubleshooting and maintenance. Each web page may be configured as dynamic, with an automatic refresh rate.

J. Local Keypad/Display:

1. For each NRC, provide a local display of at least 4 lines, providing current display of all critical inputs and outputs that the NRC is controlling. Provide a keypad such that an operator can log on, scroll through point values, and change setpoints that are changeable. The keypad/display must be capable of being mounted either on the controller, or on a control panel door.

2.18 STANDALONE DIGITAL CONTROL UNITS (SDCUS)

A. General: Standalone Digital Control Units shall provide control of HVAC and lighting, including air handling units, rooftop units, variable air volume boxes, and other mechanical equipment. Each controller shall be fully programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated NRC.
Each SDCU provided must be a “native” BACnet device, supporting the BACnet Advanced Application Controller (B-AAC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).

B. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.

C. Communication Ports: SDCUs shall have a RS-485 communication port to the BACnet MS/TP field bus, operating at a speed of at least 76.8 kbps.

D. Input/Output: Each SDCU shall have enough inputs and outputs to meet the application’s required point count. Each SDCU shall support universal inputs, whereas any input may be software-defined as:

1. Digital Inputs for status/alarm contacts
2. Counter Inputs for summing pulses from meters.
3. Thermistor Inputs for measuring temperatures in space, ducts and thermowells.
4. Analog inputs for pressure, humidity, flow and position measurements.

E. SDCU’s must support both digital and analog output types:

1. Digital Outputs for on/off equipment control.
2. Analog Outputs for valve and damper position control, and capacity control of primary equipment.

F. Expandability: For larger controllers (16 base inputs and up), provide input and output expansion through the use of plug-in modules. At least two I/O modules must be capable of being added to the base SDCU.

G. Hardware Override Switches: All digital outputs on air handling unit controllers shall include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output on air handling unit controllers shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

H. Room Sensor Support: The SDCU shall support a basic room thermistor in plain plastic cover; a room sensor with override and setpoint adjust slider; and, a sensor with a one-line display and 6-button keypad. The display sensor shall be able to display the current temperature, setpoint, outside air temperature, relative humidity and setpoint, occupancy mode, and CFM of the individual zone.

I. Networking: Each SDCU will be able to exchange information on a peer to peer basis with other Standalone Digital Control Units, according to the BACnet MS/TP protocol. Each SDCU shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each SDCU shall be able to have its program viewed and/or enabled/disabled through a workstation connected to an NRC.
J. Indicator Lamps: SDCUs will have as a minimum, LED indication of CPU status, and field bus status.

K. Real Time Clock (RTC): All SDCUs shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each SDCU shall receive a signal, every hour, over the network from the NRC, which synchronizes all SDCU real time clocks.

L. Automatic Restart After Power Failure: Upon restoration of power, the SDCU shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

M. Battery Back Up: All SDCUs shall store all programming in non-volatile FLASH memory. All SDCUs except terminal controllers shall include an on-board lithium battery to back up the controller’s RAM memory. The battery shall have a shelf life of over 10 years, and provide accumulated backup of all RAM and clock functions for at least 3 years. In the case of a power failure, the SDCU shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the SDCU shall restart itself from its application program stored in its FLASH memory.

N. Software – General: The SDCU shall contain FLASH memory to store both the resident operating system AND the application software. There will be no restrictions placed on the type of application programs in the system. Each SDCU shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

O. User Programming Language: The application software shall be user programmable, using the same language as that defined for Network Router/Controllers. Controllers that use a “canned” program method will not be accepted.

P. Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Router/Controller.

Q. History Logging: Each controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.

R. Alarm Management: For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the SDCU and can result in the display of one or more alarm messages or reports.

1. Up to 8 alarms can be configured for each point in the controller.
2. Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
3. If communication with the Operator Workstation is temporarily interrupted, the alarm will be time-stamped and buffered in the controller. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.

4. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

2.19 AIR HANDLER/RTU, OUTSIDE AIR UNITS AND CHILLER/BOILER CONTROLLERS

A. Controllers shall conform to the BACnet Advanced Application Controller (B-AAC) device profile.

B. Controllers shall be capable of meeting the requirements of the sequence of operation found in the Execution portion of this specification and for future expansion.

C. Controllers shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.

D. Controllers shall be fully user programmable to allow for modification of the application software.

E. A manual override switch shall be provided for all digital and analog outputs on the Controller. The position of the switch shall be monitored in software and available for operator displays and alarm notification.

F. Local Keypad/Display: For each SDCU, provide a local display of at least 4 lines, providing current display of all critical inputs and outputs that the SDCU is controlling. Provide a keypad such that an operator can log on, scroll through point values, and change setpoints that are changeable. The keypad/display must be capable of being mounted either on the controller, or on a control panel door.

2.20 VAV AND FP BOX TERMINAL UNIT CONTROLLERS

A. VAV Controllers shall conform to the BACnet Advanced Application Controller (B-AAC) device profile.

B. VAV Terminal Unit Controllers shall support, but not be limited to the control of the following configurations of VAV boxes to address current requirements as described in the Execution portion of this specification, and for future expansion:

1. Single Duct Cooling Only
2. Single Duct Cooling with Reheat (Electric or Hot Water)
3. Fan Powered (Parallel or Series)
4. Dual Duct (Constant or Variable Volume)
5. Supply/Exhaust

C. VAV Controllers for single duct applications will come equipped with a built-in actuator for modulation of the air damper. The actuator shall have a minimum torque rating of 35 in.-lb.,
and contain an override mechanism for manual positioning of the damper during startup and service.

D. VAV Controllers shall contain an integral velocity sensor accurate to +/- 5% of the box’s CFM rating.

E. Each controller shall perform the sequence of operation described in Part 3 of this specification, and have the capability for local time of day scheduling, occupancy mode control, after hours operation, lighting control, alarming, and trending.

F. VAV Controllers shall be able to communicate with any other Standalone Digital Control Unit on the same MS/TP field bus.

2.21 UNITARY CONTROLLERS

A. Unitary Controllers shall conform to the BACnet Advanced Application Controller (B-AAC) device profile.

B. Unitary Controllers shall support, but not be limited to, the control of the following systems as described in the Execution portion of this specification, and for future expansion:
   1. Fan Coils
   2. Packaged Rooftops
   3. Fan Coils (2 or 4 Pipe)

C. The I/O of each Unitary Controller shall contain the sufficient quantity and types as required to meet the sequence of operation found in the Execution portion of this specification. In addition, each controller shall have the capability for local time of day scheduling, occupancy mode control, after hour operation, lighting control, alarming, and trending.

D. Unitary Controllers shall be able to communicate with any other Standalone Digital Control Unit on the same MS/TP field bus.

2.22 BACNET GATEWAY TO THIRD-PARTY DEVICES

A. General: Where required, provide a BACnet Gateway to interface to non-BACnet systems that use the Modbus protocol, LONworks protocol, or other proprietary protocol. The Gateway shall communicate directly over Ethernet TCP/IP, and shall use the BACnet/IP protocol to communicate with a BACnet Workstation (B-OWS). Systems that use a PC to act as a gateway are not acceptable.

B. Communication Ports: In addition to its on-board Ethernet port, the Gateway shall have at least two serial communications ports for interfaces to third-party systems.

C. Memory: The Gateway shall have enough RAM memory to store all point configuration data, plus required history logging and alarm buffering. Minimum RAM shall be 8MB. The operating system of the gateway must be stored in FLASH non-volatile memory.

D. User Programming Language: The Gateway shall employ the same user programmable application software that NRCs and SDCUs use.
E. Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Router/Controller. Gateways that do not have an application programming language will not be accepted.

F. History Logging: Each Gateway shall be capable of LOCALLY logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.

2.23 DDC SENSORS AND POINT HARDWARE

A. Temperature Sensors

1. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
2. Standard space sensors shall be available in an off white enclosure for mounting on a standard electrical box.
3. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
4. Where a local display is specified, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
5. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors are useable in air handling applications where the coil or duct area is less than 14 square feet.
6. Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube must contain at least one thermistor for every 3 feet, with a minimum tube length of 12 feet.
7. Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
8. A pneumatic signal shall not be allowed for sensing temperature.

B. Humidity Sensors

1. Humidity devices shall be accurate to +/- 5% at full scale for space and +/- 3% for duct and outside air applications. Suppliers shall be able to demonstrate that accuracy is NIST traceable.
2. Provide a hand held field calibration tool that both reads the output of the sensor and contains a reference sensor for ongoing calibration.

C. Pressure Sensors
1. Air pressure measurements in the range of 0 to 10” water column will be accurate to +/- 1% using a solid-state sensing element. Acceptable manufacturers include Modus Instruments and Mamac.

2. Differential pressure measurements of liquids or gases shall be accurate to +/- 0.5% of range. The housing shall be Nema 4 rated.

D. Current and KW Sensors

1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in solid and split core models, and offer either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris or approved equal.

2. Measurement of three phase power shall be accomplished with a kW/kWH transducer. This device shall utilize direct current transformer inputs to calculate the instantaneous value (kW) and a pulsed output proportional to the energy usage (kWH). Provide Veris Model 6000 Power Transducer or approved equal.

E. Water Flow Sensors

1. Provide an insertion vortex flowmeter for measurement of liquid, gas or steam flows in pipe sizes above 3 inches.

2. Install the flow meter on an isolation valve to permit removal without process shutdown.

3. Sensors shall be manufactured by EMCO or approved equal.

F. Smoke Detectors

1. Air duct smoke detectors shall be provided and installed by the Division 26 Electrical Contractor. The detectors shall operate at air velocities from 300 feet per minute to 4000 feet per minute.

2. BAS subcontractor shall provide all control interlocking wiring as indicated on drawings to shut down respective fan upon activation of smoke detector.

G. Airflow Measuring

1. Provide a thermal anemometer using instrument grade self heated thermistor sensors with thermistor temperature sensors.

2. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.

3. The output signal shall be linear with field selectable ranges including 0-5 VDC, 0-10VDC and 4-20 mA.

H. Thermostat Guard

3.1 CONTRACTOR RESPONSIBILITIES

A. General

1. Installation of the Building Automation System shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the BAS subcontractor. The BAS subcontractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

B. Demolition

1. Remove controls which do not remain as part of the integrated building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor.

C. Access to Site

1. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner’s Representative.

D. Code Compliance

1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in Division 15975 and Division 16, wiring requirements of Division 15975 will prevail for work specified in Division 15975.

E. Cleanup

1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

3.2 WIRING, CONDUIT, AND CABLE

A. All wiring requirements shall conform to these standards outlined in Division 16.

B. All wire will be copper and meet the minimum wire size and insulation class listed below:

<table>
<thead>
<tr>
<th>Wire Class</th>
<th>Wire Size</th>
<th>Isolation Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>12 Gauge</td>
<td>600 Volt</td>
</tr>
<tr>
<td>Class One</td>
<td>14 Gauge Std.</td>
<td>600 Volt</td>
</tr>
<tr>
<td>Class Two</td>
<td>18 Gauge Std.</td>
<td>300 Volt</td>
</tr>
<tr>
<td>Class Three</td>
<td>18 Gauge Std.</td>
<td>300 volt</td>
</tr>
</tbody>
</table>
Communications Per Mfr. Per Mfr.

C. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.

D. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

E. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 3/4 inch galvanized EMT. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

F. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be used in exterior locations and interior locations subject to moisture.

G. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

H. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Plenum rated wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to connect the system to the fire management system shall be in conduit.

I. Conduit is required in all mechanical rooms, boiler room, equipment rooms, and in all concealed spaces.

J. All electric wiring in conjunction with the automatic temperature control system shall be furnished and installed by the control manufacturer including fan interlocking, low voltage control wiring, access control and intrusion, and communication wiring. All power wiring and 110V control power shall be by the control manufacturer/installer. Control manufacturer installer shall provide power as required from the nearest electrical panel. Control manufacturer shall provide all breakers, transformers, etc., in order to complete the installation outlined in these specifications.

3.3 HARDWARE INSTALLATION

A. Installation Practices for Wiring

1. All controllers are to be mounted vertically and per the manufacturer’s installation documentation.

2. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.

3. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
4. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.

5. Conduit in finished areas, will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.

6. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.

7. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.

8. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.

9. Wire will not be allowed to run across telephone equipment areas.

10. Sensors, humidistats, and thermostats shall be installed with high side reach of 48” where not installed over casework. Where installed over casework the high side reach shall be 44” or as required to comply with ADA. Exceptions shall be where installed in ductwork or other locations not meant to be accessible to other than service personnel.

11. Install thermostat guards on sensors, humidistats, and thermostats located in the gang toilet rooms, lobbies, corridors, vestibules, cafeterias, and other public areas.

B. Installation Practices for Field Devices

1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.

2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.

3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

5. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.

6. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

C. Enclosures

1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The BAS subcontractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.

2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.

3. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.

4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.

5. All outside mounted enclosures shall meet the NEMA-4 rating.
6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

D. Identification

1. Identify all control wires with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
2. All field enclosures, other than controllers, shall be identified with a bakelite nameplate. The lettering shall be in white against a black or blue background.
3. Junction box covers will be marked to indicate that they are a part of the BAS system.
4. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.
5. All I/O field devices inside FIP's shall be labeled.

E. Existing Controls and Security Devices.

1. Existing controls and devices which are to be reused must each be tested and calibrated for proper operation. Existing controls which are to be reused and are found to be defective requiring replacement, will be noted to the Owner. The Owner will be responsible for all material and labor costs associated with their repair.

F. Control System Switch-Over

1. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.
2. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.
3. The BAS subcontractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.

G. Location

1. The location of sensors is per mechanical, electrical and architectural drawings.
2. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.
3. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.4 SOFTWARE INSTALLATION

A. General

1. The BAS subcontractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.
B. Database Configuration
   1. The BAS subcontractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

C. Color Graphic Displays
   1. Unless otherwise directed by the Owner, the BAS subcontractor will provide color graphic displays as depicted in the project drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for set-point changes as required by the owner.

D. Reports
   1. The BAS subcontractor will configure a minimum of 6 HVAC reports for the owner as listed below:
      a. Central Plant Status Report
      b. Air Handler Status Report
      c. VAV Status Report
      d. Space Temperature Report
      e. Specialty Equipment Status Report
   2. The BAS subcontractor will also configure a minimum of 10 Security reports for the owner as listed below:
      a. Access Events, by time, by department, by door
      b. Alarm Events, by date and by priority
      c. Personnel, by name, by department, by card number, by expiration status
      d. Door Status
      e. Area/Door/personnel cross reference reports

E. Documentation
   1. As built software documentation will include the following:
      a. Descriptive point lists
      b. Application program listing
      c. Application programs with comments.
      d. Printouts of all reports.
      e. Alarm list.
      f. Printouts of all graphics

3.5 COMMISSIONING AND SYSTEM STARTUP
A. Point to Point Checkout
   1. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner’s representative.
B. Controller and Workstation Checkout

1. A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner’s representative by the completion of the project.

C. System Functional Performance Testing

1. All application software will be verified and compared against the sequences of operation. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.

2. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.

3. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.

4. The BAS subcontractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer’s representatives, as applicable, and the Owner and Architect’s representatives.

5. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

D. Successful completion of the Functional Performance Test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

E. The BAS subcontractor shall provide all manpower and engineering services required to assist the Commissioning Agent in testing, adjusting, and balancing all systems in the building. The BAS subcontractor shall have a trained technician available on request during the balancing of the systems. The BAS subcontractor shall coordinate all requirements to provide a complete air balance with the balancing agency and shall include all labor and materials in his contract.

3.6 MISCELL ANEOUS HVAC REQUIREMENTS

A. The temperature control system and its related auxiliaries are installed to:
1. Regulate the temperature of conditioned spaces.
2. Provide for safe operation of the system.
3. Protect equipment against damage by freezing.

B. Equipment furnished shall produce the results specified later herein and shall also accomplish the above purposes.
C. Furnish all thermostats and sensors, switches, transformers, relays, motor-operated valves, motor-operated dampers, and all other control auxiliaries which may be required to accomplish the control cycles specified later herein.

D. All control devices shall have sufficient means of adjustment to permit all necessary field adjustments which may be required to obtain the results intended by this specification.

3.7 THERMOSTATS AND SENSORS

A. Ranges specified for thermostats and sensors refer to the range of temperature within which the thermostat may be adjusted to control temperature. With change in season, some thermostats and sensors may be subjected to temperatures outside of the specified range. Carefully examine the drawings and specifications to determine which instruments may be so affected. Instruments furnished for these locations shall be carefully selected so that they may be subjected to the anticipated temperature range without damage to the instrument or adverse effect on the control operation.

B. The approximate location of thermostats and sensors is indicated either in these specifications or on the contract drawings. BAS subcontractor is, however, responsible for the final selection of all thermostat locations. Room thermostats and sensors shall be located as shown on the drawings, but if there are any questions concerning correctness of location, notify the Architect before installing thermostats and sensors. Locate thermostats and sensors so the control results intended and implied by these specifications are accomplished. Select thermostats and sensors to have adequate size and sufficient sensitivity to accurately measure the temperature of the air or water stream being controlled and to produce the control results specified later herein.

C. Use remote bulb devices when it is necessary to locate temperature sensitivity elements more than 6 feet above the floor or in other locations which are not readily accessible. Install instruments, relays, etc. on instrument panels or in other locations which are accessible for observation and adjustment to a man standing on the floor.

D. Install separable, stainless steel or brass wells for all new immersion thermostats and sensors.

E. Whether a thermostat is to be positive or gradual action is indicated in the control cycle specifications which follow.

F. Coordinate the work of various subcontractors to the end that all thermostats and sensors will properly measure the mean temperature of the air being controlled and that thermostats and sensors are not adversely affected by baffles or flanges around heating or cooling coils.

G. New room thermostats and sensors shall have a range of not less than 55°F to 85°F unless otherwise noted. Furnish with thermometers and with open, manual adjustment by room occupant. Set stops initially for 70°F to 76°F. Provide a jack on each sensor to provide access to the status and operating parameters of the terminal device linked to the sensor.

H. Submit covers for all new room thermostats and sensors to the Engineer for his selection and approval. Where indicated provide metal guards for thermostats and sensors. Guard shall be Shaw Perkins Series 16 or approved equal.
I. For ADA compliance the high side reach to all new thermostats and sensors shall be 48”. where not installed over casework. Where installed over casework the high side reach shall be 44” or as required to comply with ADA.

3.8 CONTROL VALVES

A. New automatically controlled valves shall be 150 PSI class, globe or angle pattern valves. Three-way butterfly valves are NOT acceptable. Flow shall remain constant through its full throttle range. Maximum pressure change at a constant flow rate shall be 1 PSIG. All single seated valves shall have equal percentage flow characteristics where the percentage of stem travel is roughly proportional to the amount of heat output. Valves 2” and smaller shall be bronze body, threaded end valves. Valves larger than 2” shall be flanged end, iron body, bronze trimmed. It is of extreme importance to the satisfactory operation of the system that there is no leakage when valves are closed.

B. New automatic control valves shall provide "dead-end" shut-off at a pressure difference of 50 PSI between inlet and outlet of valve. Leakage of water through valves in the closed position will be sufficient cause to reject the control system. Maximum recommended differential pressure for modulating water service shall be equal to or greater than 50 P.S.I. for all two way valves. Maximum recommended pressure for quiet service shall be 50 P.S.I. In lieu of two-way, 50 P.S.I. differential pressure valves three way valves may be used at no additional cost to the Owner.

C. Furnish new valves used for modulating control with V-ports, throttling plugs, or other approved device to accomplish modulating control.

D. Install position indicators on all new valve motors whether electric or DDC.

E. Determine valve sizes from the demand for water and pressure drop available. Pressure drop refers to the loss of pressure between inlet and outlet of valve and shall be within the limits stated when valve is passing the stated amount of water or steam.

F. Valves not sized elsewhere shall be sized for a maximum 3 P.S.I. pressure drop.

G. When submitting valves for approval, valves shall be listed in a schedule format in which the unit served, GPM, pressure drop, maximum recommended differential pressure, type, model number, size, Cv, and operating range are all listed. It is permissible to combine multiple unit marks with the same flow rates into the same entry as long as all of the unit marks are listed.

3.9 DAMPERS

A. New automatically controlled dampers shall be louver pattern with air foil blades made from No. 14 U.S.S. gauge, galvanized steel. Damper frames shall have felted or neoprene edges. Damper frames shall be rigid steel, pivots and bearings shall be corrosion resistant material. Leakage shall not exceed 3.0 CFM per Sq. Ft. for a 24” wide louver at 1.0” W. G. pressure difference.

B. All new dampers shall be throttling type with adjacent blades moving in opposite direction unless the control cycle indicates that the damper will be operated by a two-positioned motor then all blades may move in the same direction.
C. Furnish new dampers with extended shafts. Install damper motors outside of ductwork unless Architect approves alternate location. Provide suitable mounting brackets so damper motors and instruments do not interfere with duct insulation.

D. Install all new dampers in a manner to maintain free operation of blades and to permit tight closing of the entire damper.

3.10 SWITCHES AND RELAYS

A. BAS subcontractor shall locate all switches, relays, and ATC contacts as close as possible to their associated starters, motors or equipment as to necessitate a minimum of line voltage, power wiring to the equipment served. Coordinate all locations with the Electrical Contractor doing the power wiring. Where necessary provide remote relays exterior to controllers and panels switching the device.

3.11 PROTECTION DEVICES

A. Freeze-stats shall be automatic reset, electric type with capillary tube thermostat with "fade-out" fill which will permit exposure of bulb to high temperature without damage to instrument. Tube shall be not less than 20 feet long. Thermostat shall respond to the lowest temperature to which any 8-inch increment is exposed. Operating range shall be not less than 25°F to 85°F. Cut-off point shall be carefully calibrated against an accurate thermometer and shall be permanently locked at 40°F.

B. Fire thermostats and sensors shall be manual reset, electric duct-type thermostats and sensors. Cut-off point shall be set at 165°F. Refer to "Control Diagram" on drawings. Fire thermostats and sensors will be required for all ventilating systems.

C. Duct mounted smoke detectors will be provided by the Electrical Contractor. Provide proper connection information on shop drawings.

3.12 WIRING RESPONSIBILITY

A. Electrical Contractor will do all power wiring to starters and motors and provide only that control wiring as shown on control diagrams on drawings. Any additional wiring deemed to be necessary to fulfill the intent of this control specification shall be the responsibility of the BAS subcontractor. Electrical Contractor shall only provide power wiring to control panels shown on the plans. Any additional power wiring to control panels, interface stations, or controllers shall be by the BAS subcontractor.

B. All freeze-stats, fire-stats, and aqua stats shall be mounted by the BAS subcontractor and wired by the Electrical Contractor, unless noted otherwise.

C. Duct mounted smoke detectors will be provided by the Electrical Contractor. Provide proper connection information on shop drawings.
D. All switches, relays and other electrical equipment supplied by the HVAC Contractor and wired by the Electrical Contractor shall be mounted in close proximity to the equipment served so as to minimize the extent of power wiring by the Electrical Contractor.

E. Where contacts are supplied by the Electrical Contractor or by other any other Contractors or by this subcontractor, the HVAC Contractor shall determine if the holding coil or electrical load imposed on the contacts is less than 70% of the contacts rating. Where contacts are not of sufficient size to handle the load, the HVAC Contractor shall wire the contact to an intermediate device, supplied by him that imposes an acceptable load on the contacts, and has sufficient capacity for the load applied by his equipment. This can be done using a properly sized relay or by using a combination of an EP and a PE switch at the Contractor's option.

3.13 VARIABLE SPEED DRIVE

A. Summary

1. This section provides specification requirements for solid-state, pulse-width modulated (PWM) Adjustable Frequency Drives, herein referred to as AC Drives, for use with NEMA® design AC motors.
2. The AC Drive supplier shall furnish, field test, adjust and certify all installed AC Drives for satisfactory operation.
3. Any exceptions/deviations to this specification shall be indicated in writing and submitted no less than one week prior to bid date.
4. The AC drive shall have an internal mounted native BACnet communication card and shall communicate at a minimum speed of 76.8kbps.

B. References

1. ANSI®/NFPA® 70 - National Electrical Code® (NEC®).
2. UL 508 - UL Standard for Safety Industrial Control Equipment.
4. NEMA ICS 7.1- Industrial Control and Systems Variable Speed Drives

C. Submittals

1. A submittal package, including drawings shall be furnished for the Engineers’ approval prior to factory assembly of the AC Drives. These packages shall consist of elementary power and control wiring diagrams on one drawing and enclosure outline drawings. The enclosure drawings shall include front and side views of the enclosures with overall dimensions and weights shown, and conduit entrance locations. Standard catalog specification sheets showing voltage, horsepower and maximum current ratings shall be furnished as part of the submittal package.

D. Warranty

1. An 18 month warranty shall be provided on materials and workmanship from the date of shipment.

E. Quality Assurance
1. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.
2. The AC Drive and all associated optional equipment shall be UL Listed according to UL 508 C - Power Conversion Equipment. As verification, a UL label shall be attached on the inside of the combination enclosure. A UL508A panel builders label does not meet specification.
3. The AC Drive shall be designed, constructed and tested in accordance with UL, CSA, NEMA, and NEC standards.
4. Every power converter shall be tested with an AC induction motor while loaded and temperature cycled within an environment chamber at 40 °C (104 °F).

F. Manufacturers

1. The AC Drive shall be manufactured by Square D Schneider Electric type Altivar 61 or Altivar 21 as required to meet the required H.P ratings and environmental/general ratings, ABB, Danfoss, Emerson Industrial Automation Affinity or approved equal. Substitutions must be submitted in writing three weeks prior to original bid date with supporting documentation demonstrating that the alternative manufacturer meets all aspects of the specifications herein. Supporting documentation should include a line by line review of this specification indicating if the substitution meets or does not meet each item in this specification.

G. General Description

1. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage.
2. The input power section shall utilize a full wave bridge design incorporating diode rectifiers. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage.
3. The output power section shall change fixed DC voltage to adjustable frequency AC voltage.
4. The adjustable frequency NEMA 1 drive package shall consist of a circuit breaker disconnect, line reactor, EMI/RFI filter (if drive design requires RFI interference protection), 2 contactor bypass, 120V control transformer, control circuit terminal board for digital and analog field wiring. AC line fuses do not meet specification.
5. The drive door shall have mounted and wired, Hand-Off-Auto switch, Manual Speed Potentiometer and AFC-Off-Bypass switch.
6. The entire drive package, including the bypass starter circuit shall be UL508C listed and coordinated with NEMA ICS 7.1. A UL508A panel builders label does not meet specification.

H. Construction

1. The AC Drive power converter shall be enclosed in a NEMA Type 1 enclosure with a circuit breaker disconnect, user terminal strip connections and bypass controls. The enclosure shall provide dedicated user terminals for power and control device connection.
2. Provisions shall be included for locking the disconnect in the OFF position with a padlock.
3. All enclosure and heat sink fans shall be accessible from the front and shall not require the removal of the AC drive power converter for fan replacement.

I. Application Data
1. The AC Drive shall be sized to operate a variable torque load.
2. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 72 Hz.

J. Environmental Ratings

1. The AC Drive shall meet IEC 60664-1 Annex A and NEMA ICS 1, UL, and CSA standards.
2. The AC Drive shall be designed to operate in an ambient temperature from -10 to 40 °C (14 to 104 °F).
3. AC Drives in Type 3R enclosures shall be designed to operate in an ambient temperature from -10 to 50 °C (14 to 122 °F) and in full sunlight.
4. The storage temperature range shall be -25 to 65 °C (-13 to 149 °F).
5. The maximum relative humidity shall be 95%, non-condensing.
6. The AC Drive shall be rated to operate at altitudes less than or equal to 3300 ft (1000 m). For altitudes above 3300 ft (1000 m), the AC Drive should be de-rated per drive specifications.
7. The AC Drive shall meet the IEC 60721-3-3-3M3 operational vibration specification.
8. The AC Drive shall be Seismic Qualified to 2000 IBC Level 3 “Extreme” rating with an Importance Factor 1p=1.5

K. Ratings

1. The AC Drive shall be designed to operate at the input line voltage indicated on the equipment schedule.
2. The AC Drive shall operate from an input frequency range of 60 Hz (±) 5%.
3. The displacement power factor shall not be less than .98 lagging under any speed or load condition.
4. The efficiency of the AC Drive at 100% speed and load shall not be less than 97%.
5. The variable torque rated AC Drive over current capacity shall be not less than 110% for 1 minute.
6. The output carrier frequency of the AC Drive shall be programmable at 0.5, 1, 2, 4 or 8 kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency.

L. Protection

1. Upon power-up, the AC Drive shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-charge circuit.
2. The enclosure shall provide a fully coordinated 100,000 AIC current rating marked on the enclosure nameplate. Short circuit coordination to UL 508C Power Conversion Equipment and NEMA ICS 7.1.
3. The AC Drive shall be protected against short circuits, between output phases and to ground.
4. The AC Drive shall have a minimum AC undervoltage power loss ride-through of 200 milliseconds (12 cycles).
5. The AC drive shall have a programmable ride-through function, which will allow the logic to maintain control for a minimum of one-second (60 cycles) without faulting.
6. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 6 programmable restart attempts. The time delay before restart attempts will be 30 seconds.
7. Upon loss of the analog process follower reference signal, the AC Drive shall be programmable to display a fault.
8. The AC Drive shall have a solid-state UL 508C listed overload protective device and meet IEC 60947.
9. The output frequency shall be software enabled to fold back when the motor is overloaded.
10. There shall be three skip frequency ranges that can be programmed to a bandwidth of ± 2.5 Hz.

M. Adjustments and Configurations
1. The AC Drive will be factory programmed to operate all specified optional devices.
2. The acceleration and deceleration ramp times shall be adjustable from 0.05 to 999.9 seconds.
3. The memory shall retain and record run status and fault type of the past eight faults.
4. The software shall have an energy economy function that, when selected, will reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load. Selectable volts/Hz ratio patterns does not meet specification, the function must be automatically optimized.

N. Keypad Display Interface
1. A keypad display interface shall offer the modification of AC Drive adjustments through a touch keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, and adjustment storage, and diagnostics shall be accessible.
2. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall be listed on the drive identification portion of the LCD display.
3. The keypad display shall have a hardware selector switch that allows the keypad to be locked out from unauthorized personnel.

O. Operator Controls
1. The control power for the digital inputs and outputs shall be 24 Vdc.
2. The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and will not be damaged if shorted.
3. Pull-apart terminal strips shall be used on all logic and analog signal connections in the power converter.
4. Two voltage-free relay output contacts will be provided. One of the contacts will indicate AC Drive fault status. The other contact shall indicate a drive run status.
5. The combination enclosure shall have the following dedicated operator controls:
   a. Hand-Off-Auto switch
   b. Manual Speed Potentiometer
   c. AFC-Off-Bypass switch
6. The combination enclosure shall include terminal point connection for fire /freeze state interlock, to prevent drive [or bypass] operation. The interlock must shut down the motor in the drive and bypass modes.

P. Bas Communication Interface & Serial Communication
1. The AC drive shall have an internal mounted native BACnet communication card and shall communicate at a minimum speed of 76.8kbps.

Q. Drive Isolation And Bypass Contactors

1. The AC Drive shall include mechanically and electrically interlocked isolation and bypass contactors complete with a Class 20 thermal overload relay, circuit breaker disconnect, control circuit transformer and AFC/OFF/BYPASS switch.
2. The operator shall have full control of the bypass starter by operation of the AFC/OFF/BYPASS selector switch.
3. In the AUTOMATIC mode of operation the bypass contactors shall be sequenced by the 120-volt rated auto start contact provided by the BAS subcontractor.
4. The isolation contactor for the bypass shall be sequenced to provide motor isolation during a drive ready state of operation.

R. Harmonic Mitigation

1. Each drive shall include a line reactor mounted inside the drive enclosure to reduce power system harmonics and provide power quality protection for the drive. DC bus chokes do not meet specification and shall not be substituted.

S. Inspection

1. Verify that the location is ready to receive work and the dimensions are as indicated.

T. Protection

1. Before and during the installation, the AC Drive equipment shall be protected from water and site contaminants.

U. Installation

1. Installation shall be in compliance with manufacturer's instructions, drawings and recommendations.
2. The AC Drive supplier shall provide a representative to inspect the Contractor's installation, test and start-up the AC Drive(s) furnished under this specification.

V. Training

1. On-site training shall be provided as part of the start-up service.

W. Documentation

1. The AC Drive supplier shall supply a comprehensive 8-1/2 x 11-inch bound instruction and installation manual that includes wiring diagrams, layout diagrams, and outline dimensions. This manual must be 3-hole punched for insertion in a shop manual supplied by the installing Contractor.

3.14 D.D.C. CONTROL SEQUENCES AND FUNCTIONS

A. Refer to Specification Section 230993 – Sequence of Operation for HVAC Controls.
END OF SECTION 23 6000
SECTION 23 6426 - ROTARY SCREW WATER CHILLER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All Division 23 Specification Sections also apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, air-cooled, electric-motor-driven, rotary-screw water chillers with the following features:
   1. Motor controller.

1.3 DEFINITIONS

A. EER: Energy-efficiency ratio.

B. IPLV: Integrated part-load value.

1.4 SUBMITTALS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Complete set of manufacturer's certified prints of water chiller assemblies, control panels, sections, and elevations, and unit isolation. Include the following:
   1. Assembled unit dimensions.
   2. Operating weight and load distribution.
   3. Required clearances for maintenance and operation.
   4. Size and location of piping and wiring connections.
   5. Vibration Isolation Calculations and Details: Signed and sealed by a qualified professional engineer.
      a. Design Calculations: Calculate requirements for selecting vibration isolators.

C. Coordination Drawings: Floor plans drawn to scale and coordinated with the following:
SECTION 23 7200 - ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes modular packaged air cooled rooftop energy recovery units with heating and cooling systems and energy recovery wheel for rooftop curb mounted outdoor installations.

B. All Division 23 Specification Sections also apply to this Section.

1.2 ABBREVIATIONS

A. BAS - Building Automation System

B. RTU - Rooftop Unit

1.3 SUBMITTALS

A. Product Data: For each air-handling unit indicated.
   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:
      a. Certified fan-performance curves with system operating conditions indicated.
      b. Certified fan-sound power ratings.
      c. Fan construction and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.
   4. Certified coil-performance ratings with system operating conditions indicated.
   5. Dampers, including housings, linkages, and operators.
   6. Filters with performance characteristics.

C. Source quality-control reports.

D. Field quality-control reports.

E. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
SECTION 23 7313 - MODULAR INDOOR AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes modular air handling units with heating and cooling systems and energy recovery wheel for indoor installations.

B. All Division 23 Specification Sections also apply to this Section.

1.2 ABBREVIATIONS

A. BAS - Building Automation System

B. AHU - Air Handling Unit

1.3 SUBMITTALS

A. Product Data: For each air-handling unit indicated.
   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:
      a. Certified fan-performance curves with system operating conditions indicated.
      b. Certified fan-sound power ratings.
      c. Fan construction and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.
   4. Certified coil-performance ratings with system operating conditions indicated.
   5. Dampers, including housings, linkages, and operators.
   6. Filters with performance characteristics.

C. Source quality-control reports.

D. Field quality-control reports.

E. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
SECTION 23 7413 - PACKAGED, OUTDOOR, ROOFTOP AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes modular packaged rooftop air-handling units with heating and cooling systems and coils for rooftop curb mounted outdoor installations.

1.2 ABBREVIATIONS
A. BAS – Integrated Building Automation System
B. RTU - Rooftop Unit

1.3 SUBMITTALS
A. Product Data: For each air-handling unit indicated.
   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:
      a. Certified fan-performance curves with system operating conditions indicated.
      b. Certified fan-sound power ratings.
      c. Fan construction and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.
   4. Certified coil-performance ratings with system operating conditions indicated.
   5. Dampers, including housings, linkages, and operators.
   6. Filters with performance characteristics.
B. Source quality-control reports.
C. Field quality-control reports.
D. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
SECTION 23 8123 - COMPUTER-ROOM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. These specifications describe requirements for a precision environmental control system. The system shall be designed to maintain temperature and humidity conditions in the rooms containing electronic equipment. The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements of the room.

1.3 SUBMITTALS

A. Comply with Division 1, Shop Drawings, Product Data, and Samples.

B. Product Data: Include rated capacities; shipping, installed, and operating weights; Piping and Electrical Connection Drawings; furnished specialties; and accessories for each model indicated.

C. Shop Drawings: Single line system diagrams, Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, electrical data, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

D. Maintenance Data: For equipment to include in the maintenance manuals specified in Division 1.

E. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."


C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
SECTION 23 8126 - DUCTLESS SPLIT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes split-system air-conditioning units consisting of:
   1. Indoor ductless fan coil units.
   2. Outdoor condensing units.

1.3 SUBMITTALS
A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
   1. Include diagram power, signal, and control wiring.
B. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
D. ARI210 - Unitary Air-Conditioning Equipment
E. ARI270 - Sound Rating of Outdoor Unitary Equipment
F. Units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
SECTION 238213 – VALANCE HEATING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All Division 23 Specifications Sections also apply to this Section

1.2 SUMMARY

A. This Section includes the following:

1. Hydronic heating panels.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, specialties, and accessories for each product. Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and suspension and attachment. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Color Chart: For units with factory-applied color finishes, for selection by Architect.

C. Operation and Maintenance Data: For electric radiant heaters and panels to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

A. Coordinate layout and installation of radiant heaters and panels and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
SECTION 23 8219 - FAN COIL UNITS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, other Division 1 Specification sections, and the requirements listed in Section 15000, apply to work of this section.

1.2 WORK INCLUDED

A. Horizontal Fan Coil Units
B. Vertical Fan Coil Units

1.3 RELATED WORK

A. Section 15040 - Testing, Balancing, and Adjusting
B. Section 15050 - Basic Materials and Methods
C. Section 15060 - Pipe and Pipe Fittings
D. Section 15210 - Vibration Isolation
E. Section 15840 - Ductwork
F. Section 15880 - Air Treatment Equipment
G. Section 15900 - Building Automation System
H. Section 15940 - Sequence of Operation

1.4 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 15000, Mechanical General Provisions.

B. Include wiring diagrams, sound data, and manufacturer’s written installation instructions.

C. Submit color samples for exposed finishes to the Architect for approval.

D. Submit shop drawings and product data for the following:
   1. Horizontal Fan Coil Units
   2. Vertical Fan Coil Units
SECTION 23 8239 - UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes cabinet unit heaters with centrifugal fans and hot-water and electric-resistance heating coils.

1.3 DEFINITIONS
   A. BAS: Building automation system
   B. CWP: Cold working pressure.
   C. PTFE: Polytetrafluoroethylene plastic.
   D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS
   A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
   B. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.
   C. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 EXTRA MATERIALS
   A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 26.

B. This section is a Division 26 Common Work Results for Electrical section, and is a part of each Division 26 Section.

C. Requirements of the following Division 26 Sections apply to this section:

1. 26 0500: Common Work Results for Electrical.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1 - reference individual sections for further expansion of these requirements:

1. Pre-construction Meeting
2. Abbreviations and Definitions
3. Permits, Codes, and Inspections
4. Utilities
5. Visiting Premises
6. Submittals
7. Project Drawings and Specifications
8. Cooperation and Coordination with Other Trades
9. Space Priority
10. Product Listing
11. Nameplate Data
12. Record Documents
13. Maintenance Manuals
14. Warranty
15. Performance of Equipment
16. Delivery, Storage, and Handling
17. Sequence of Work
18. Rough-ins
19. Electrical Installations
20. Cutting and Patching
21. Cleaning
22. Testing
23. Instructions to the Owner
B. Related Sections: The following sections contain requirements that relate to this section:

1. Division 23 Section "ELECTRICAL REQUIREMENTS" for factory-installed motors, controllers, accessories, and connections.

1.3 ABBREVIATIONS AND DEFINITIONS

A. General: Utilize the following abbreviations and definitions for discernment within the Drawings and Specifications.

1. Abbreviations:

   a. ANSI American National Standards Institute
   b. ASA American Standards Association
   c. ASTM American Society of Testing Materials
   d. CBM Certified Ballast Manufacturers
   e. E.C. Electrical Contractor
   f. EIA Electronic Industries Association
   g. ETL Electrical Testing Laboratories, Inc.
   h. G.C. General Contractor
   i. HVAC Heating, Ventilating, Air Conditioning Contractor
   j. ICEA International Cable Engineers Association
   k. IEEE Institute of Electrical and Electronics Engineers
   l. IES Illuminating Engineering Society
   m. NEC National Electrical Code
   n. NEMA National Electrical Manufacturers Association
   o. NFPA National Fire Protection Association
   p. O.E.M. Original Equipment Manufacturer
   q. OSHA Occupational Safety and Health Administration
   r. P.C. Plumbing Contractor
   s. UL Underwriter’s Laboratories, Inc.

1.4 DEFINITIONS

A. PROVIDE means to furnish, place, erect, connect, test and turn over to Owner, complete and ready for the regular operation, the particular work referred to.

B. INSTALL means to join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation, the particular work referred to.

C. FURNISH means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application for the particular work referred to.

D. WIRING means the inclusion of all raceways, fittings, conductors, connectors, tape, junction and outlet boxes, connections, splices, and all other items necessary and/or required in connection with such work.
E. CONDUIT means the inclusion of all fittings, hangers, supports, sleeves, etc.
F. AS DIRECTED means as directed by the Architect or their representative.
G. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within double partitions or installed within hung ceilings.
H. ACCEPTED means as accepted by the Architect or their representative.
I. APPROVED means as approved by the Architect or their representative.
J. EQUAL means equivalent as approved by the Architect or their representative.
K. CONTRACTOR as stated herein shall mean Electrical Contractor.

1.5 PERMITS, CODES, AND INSPECTIONS

A. General: Contractor shall obtain and pay for all permits and inspections required by laws, ordinances, rules and regulations having jurisdiction for work included under this Contract, and shall submit approval certificates to the Architect.

B. Codes: The electrical installation shall comply fully with all local, county and state laws, ordinances and regulations applicable to electrical installations.

C. The Electrical installation shall be in compliance with the requirements of the latest revisions of:

1. Occupational Safety and Health Act (OSHA)
2. Institution of Electrical and Electronic Engineers (IEEE)
3. National Electric Code (NEC)
5. National Board of Fire Underwriter's (NBFU)
6. Middle Department Inspection Agency (MDIA)

   a. Exception: Where the regulations of the local municipality require inspection services by an agency other than MDIA.

7. Underwriter's Laboratories, Inc. (UL)
8. National Electrical Manufacturer's Association (NEMA)
9. National Electrical Contractor's Association (NECA)
11. Legislative Act 235 (1965) - Handicapped
12. Legislative Act 287 (1974) - Excavation
14. Americans with Disabilities Act (ADA)
15. All local codes and ordinances in effect and having jurisdiction.
16. All requirements of electric, telephone, and CATV utility companies.
17. All approved published instructions set forth by equipment manufacturers.
D. Submit certificates issued by approved authorized agencies to indicate conformance of all work with the above requirements, as well as any additional certificates as may be required for the performance of this contract work.

E. Should any change in Drawings or Specifications be required to comply with governmental regulations, the Contractor shall notify Architect prior to execution of the work. The work shall be carried out according to the requirements of such code in accordance with the instruction of the Architect and at no additional cost to the Owner.

F. Certificate of Inspection: The Contractor shall procure and pay for the Certificate of Inspection from MDIA, or other required inspection agency, and deliver it to the Architect before final payment is made.

1.6 UTILITIES

A. General:
   1. The Contractor shall cooperate fully with local utility companies with respect to their services.
   2. The Contractor shall be responsible for all coordination and scheduling of construction with all utility companies as necessary for the performance of this Contract work.

1.7 FEES

A. The actual amount of the charges will be determined by the electric utility company at the time of the installation, and shall be paid directly by the Owner.

1.8 VISITING PREMISES

A. General: The Bidder shall visit the project site before submitting his bid, in order to familiarize himself with existing conditions that may affect his work. It is the Contractor's responsibility to analyze existing conditions. Sufficient allowances shall be provided in the Contractor's bid to cover work, due to existing conditions, that will be required to complete this contract work.

B. By submission of a bid, the Contractor is attesting that responsible personnel did in fact visit the site during the bidding period and verified all existing pertinent conditions.

C. Contractor shall verify all measurements and dimensions at the site prior to submitting a bid.

1.9 SUBMITTALS

A. General: Follow the procedures specified in Division 1 and as stated below.

B. Submit for approval a complete Material Source of Supply and Subcontractor list for all electrical work required under this project. Shop drawing submittals will not be reviewed until a complete Material Source of Supply and Subcontractor list is received.
C. Submittal of shop drawings, product data, and samples will be accepted only when submitted by
the Contractor. Data submitted from subcontractors and material suppliers directly to the
Architect will not be processed.

D. Prepare and submit detailed shop drawings for materials, systems and equipment as listed
herein, including locations and sizes of all openings in floor decks, walls and floors.

E. The work described in any shop drawing submission shall be carefully checked for all
clearances (including those required for maintenance and servicing), field conditions,
maintenance of architectural conditions and proper coordination with all trades on the job. Each
submitted shop drawing shall include a certification that all related job conditions have been
checked and that no conflict exists.

F. All shop drawings shall be stamped by the Contractor, indicating approval, and space shall be
provided for the Engineer's stamp and the Architect's stamp.

G. All drawings shall be submitted sufficiently in advance of field requirements to allow ample
time for checking and resubmittal as may be required. All submittals shall be complete and
contain all required and detailed information.

H. Acceptance of any submitted data or shop drawings for material, equipment apparatus, devices,
arrangement and layout shall not relieve the Contractor from responsibility of furnishing all
items of proper dimensions, weight, capacities, sizes, quantity and quality as intended by the
Contract. Such acceptance shall not relieve Contractor from responsibility for errors, omissions
or inadequacies of any sort on submitted data or shop drawings.

I. Each shop drawing shall contain job title and reference to the applicable drawing and
specification article, including the contractor's drawings, specifications and verification of
compatibility with the systems involved.

J. Individual shop drawing submittals shall be provided for each specific material, system or
equipment as identified herein. Submittals provided in other than this manner will be return
without review.

K. All nameplate data shall be complete at time of equipment submittals - refer to other sections
for identification requirements.

L. For each room or area of the building containing switchboards, panelboards, transformers,
emergency generators, telephone backboards, fire alarm control panels, etc., coordination
drawings are required to be submitted for review and acceptance at the time of the equipment
submittal.

M. Equipment shall not be ordered or purchased until the shop drawing approval is received.

N. Shop Drawings shall show conformance with specified electrical characteristics, or Contractor
shall assume responsibility for all deviations including all additional costs involved for the
deviations.
O. The following is a list of some important material, equipment and systems that require shop drawing approval, refer to each section of this specification for additional submittal requirements:

<table>
<thead>
<tr>
<th>Safety Switches</th>
<th>Outlet Boxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panelboards</td>
<td>Conductors</td>
</tr>
<tr>
<td>Switchboards</td>
<td>Fuses</td>
</tr>
<tr>
<td>Time Switches</td>
<td>Circuit Breakers</td>
</tr>
<tr>
<td>Contactors</td>
<td>Transformers</td>
</tr>
<tr>
<td>Relays</td>
<td>Lighting Fixtures</td>
</tr>
<tr>
<td>Wiring Devices</td>
<td>Metering Equipment</td>
</tr>
<tr>
<td>Emergency Power Equipment</td>
<td>Fire Alarm System</td>
</tr>
<tr>
<td>Dimming Systems</td>
<td>Disconnect Switches</td>
</tr>
<tr>
<td>Surge Suppressors</td>
<td>Network Lighting Controls</td>
</tr>
<tr>
<td>Wiring/Cables</td>
<td></td>
</tr>
</tbody>
</table>

P. System submittals (Emergency Power, etc.) shall include plan, riser and wiring diagrams complete with all wiring and required equipment.

Q. Product Options:

1. The product manufacturers listed in each section are either the product the design is based on or a product that the Engineer feels would be an acceptable substitution if that product can meet the intent of the written specifications and the scheduled capacities. The Electrical Contractor is responsible for ensuring that the substituted product complies with the intent of the specifications, the scheduled capacities and the drawings. Substitutions of manufacturers not listed are not permitted unless prior approval is obtained from the Engineer as required by Part 2.2, SUBSTITUTIONS, of this specification section.

2. It will be the responsibility of the Electrical Contractor to pay any and all costs associated with any approved substitutions that impact the architectural layout, structure, electrical system(s), mechanical systems, and/or the plumbing systems, due to an increase in physical dimensions, weight, electrical requirements, connection sizes, etc., between the approved substitution item and the equipment item scheduled and/or indicated as the basis of design.

1.10 PROJECT DRAWINGS AND SPECIFICATIONS

A. Contractor shall carefully examine the Drawings and Specifications of all trades and report all discrepancies to the Architect in writing to obtain corrective action. No departures from the Contract Documents will be made without prior written approval from the Architect.

B. Questions or disputes regarding the intent or meaning of Contract Documents shall be resolved by the interpretation of the Architect. The Architect's interpretation is final and binding.

C. The Drawings and Specifications are not intended to define all details, finish materials, and special construction that may be required or necessary. The Contractor shall provide all installations complete and adequate as implied by the project documents.
D. Drawings are diagrammatic only and do not show exact routes and locations of equipment and associated wiring. The Contractor shall verify the work of all other trades and shall arrange his work to avoid conflicts. In the event of a conflict, the Contractor shall obtain corrective action from the Architect.

E. All work shall be considered new, unless noted otherwise.

1.11 COOPERATION AND COORDINATION WITH OTHER TRADES

A. This Electrical Contractor must cooperate completely and coordinate work with the contractors of other trades providing equipment under this division and other divisions of the specifications. This is particularly important in connection with Divisions 21, 22, and 23 - Mechanical.

B. Interference drawings shall be prepared as a combined effort of all trades. The Electrical Contractor shall prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations on mylar backgrounds prepared by the Mechanical Contractor. The Mechanical Contractor shall start their drawings immediately upon award of contract. Drawings shall be at 1/4" = 1'0" scale based on sheet size and plan location and orientation as shown on the architectural drawings. All interference drawings shall be capable of being overlaid to coordinate interferences and for printing. All congested areas and mechanical room plans shall be drawn at 3/8" = 1'0" scale.

C. After the Mechanical Contractor has finished, two reproducibles will be forwarded to the Plumbing trade who will show and coordinate the plumbing work with the other trades. After the Plumbing trade has finished, two reproducibles will be forwarded to the Electrical trade who will show and coordinate their work on the combined plans.

D. Interference plans and elevations shall show in detail the location of the following items that require coordination because of size and proximity to other equipment and systems. Drawings shall show in order of installation priority within the allotted space the items prioritized in the following paragraph entitled "Space Priority".

1. In addition, show mechanical and electrical work in equipment rooms.
2. On the interference drawings, show all electrical conduits that are 1-1/2" and larger.
3. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the work.
4. Wiring diagrams: Indicating field installed electrical power and control wiring and cabling layouts, overcurrent protective devices, equipment, and equipment connections.
5. Proposed locations of major systems, equipment and material.
7. Exterior wall penetrations.
8. Fire-rated wall and floor penetrations.
9. Ceilings that contain piping, ductwork, or equipment in congested arrangement.
10. Equipment connections and support details.
11. Exterior underground lines in common excavation.
12. Sizes and location of required concrete pads and bases.
13. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
14. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
15. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.

16. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.

E. Reproducible copies of the finished interference drawings shall be submitted to the Architect for record before actual installation work begins. Each trade shall make completed interference drawings available to their craft for installation of the work.

F. Coordinate the location of each and every electrical device with the Owner and the Architect before rough-in. The above required floor plans shall be reviewed and approved by the Owner and Architect, and shall be signed by both the Owner and the Architect.

G. Individual trade interference drawings may be used as shop drawings and/or as record drawings at the completion of the project.

1.12 SPACE PRIORITY

A. Ensure equitable use of available space for materials and equipment installed above ceilings. Allocate space in the order of priority as listed below. Items are listed in the order of priority, with items of equal importance listed under a single priority number.

1. Gravity flow piping systems
2. Vent piping systems
3. Ceiling recessed lighting fixtures
4. Concealed air terminal units, fans
5. Air duct systems
6. Sprinkler systems piping
7. Forced flow piping systems
8. Electrical conduit, wiring, control wiring

B. Order of priority does not dictate installation sequence. Installation sequence shall be as mutually agreed by all affected trades.

C. Change in order of priority is permissible by mutual agreement of all affected trades.

D. The work of a particular trade shall not infringe upon the allocated space of another trade without permission of the contractor for the affected trade.

E. The work of a particular trade shall not obstruct access for installation, operation and maintenance of the Work, materials and equipment of another trade.

1.13 PRODUCT LISTING

A. Submit for approval a complete Material Source of Supply and Subcontractor list for all electrical work required under this project. Shop drawing submittals will not be reviewed until a complete Material Source of Supply and Subcontractor list is received.
B. Submit this listing as a part of the submittal requirement specified in Division 1.

C. When two or more items of same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, and similar items used in work, except as otherwise indicated.

D. Provide products that are compatible within systems and other connected items.

1.14 NAMEPLATE DATA

A. Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplate in an accessible location.

1.15 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, indicate installed conditions for:

1. Raceway systems, size and location, for both exterior and interior.
2. Locations of control devices.
3. Distribution and branch electrical circuitry.
4. Fuse and circuit breaker size and arrangements.
5. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
6. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
7. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified in Division 1 to record the locations and invert elevations of underground installations.

B. When all work has been completed and before final acceptance, the Contractor shall furnish to the Architect a complete set of reproducible contract drawings clearly showing all contract work "as-built". Prior to delivery each drawing shall be signed and dated by the Contractor's project manager attesting to the accuracy of the as-built drawing.

C. In additional to the above referenced reproducible contract drawings, the Electrical Contractor shall furnish to the Architect a CD-Rom containing all of the floor plans. The floor plans shall be in AutoCAD 2007 format, and shall indicate the “as-built” conditions. A CD-Rom shall be provided to the Electrical Contractor prior the completion of the project, with the drawing files from the bid set of documents. The Electrical Contractor shall make changes to these files, indicating all changes made during construction, including tagging and room names. The Electrical Contractor shall make these changes or retain the services of a third party to make the changes.

D. Mark up a clean set of Specifications to indicate approved substitutions, change orders and actual equipment and materials used.
1.16 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1. In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Provide a cover sheet for each manual including the project name, Architect's name and contact information, Engineer's name and contact information, and Division 26 contractor's name and contact information.
6. Alphabetical list of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
7. Manufacturer's data of each piece of equipment including:
   a. Installation instructions.
   b. Drawings and Specifications.
   c. Parts list, including recommended items to be stocked.
   d. Complete wiring diagrams.
   e. Marked or changed prints locating all concealed parts and all variations from the original system design.
   f. Test and inspection certificates.

B. Format:

1. Provide five (5) copies of each manual.
2. Manuals to be 8-1/2 inches x 11 inches size in hardback 3-ring loose leaf binders. Use more than one volume if required; do not overfill binders.
3. Submit one (1) copy to Architect. After review and acceptance, assemble other copies.
4. Manuals to be completed and in Owner's hands prior to turning building over to Owner and at least 10 days prior to instruction to operating personnel.

1.17 WARRANTIES

A. Refer to Division 1 for procedures and submittal requirements for warranties and to individual equipment specifications for additional warranty requirements. If a contradiction exists, the most demanding requirements shall prevail.

B. Compile and assemble the warranties specified in Division 26 into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
C. Provide complete warranty information for each item to include date of beginning of warranty or bond; duration of warranty or bond; and names, address, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. Submit a single warranty stating that all portions of the work are in accordance with Contract requirements. Warrant all work against faulty and improper material and workmanship for a period of one (1) year from date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are specified herein, such longer term shall apply. Within 24 hours after notification, correct any deficiencies that occur during the warranty period at no additional cost to Owner, all to the satisfaction of the Owner and Architect. Obtain similar warranties from subcontractors, manufacturers, suppliers and sub-trade specialists.

E. Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract Documents or that are damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Major items of equipment shall have manufacturer's name, address and catalog number on a plate securely attached in a convenient place. All equipment or apparatus of any one system must be the product of one manufacturer, or approved equivalent products of a number of manufacturer's that are suitable for use in a unified system.

B. All materials and equipment for which Underwriter's Laboratories have established standards shall bear a UL label of approval.

C. In all cases where a device, function or item of equipment is herein referred to in the singular, such reference shall apply to as many such items as are required to complete the installation.

D. All listed materials and equipment shown on drawings and/or specified herein, are indicative of complete and whole units and shall be furnished as such.

E. In certain instances specific manufacturer/model/type and catalog numbers are set out herein or on the drawings for the purpose of indicating required criteria for quality, function, sound level and acceptable physical size. Specifications, performance data, and descriptive data published by the designated manufacturer shall be taken as minimum requirements for the item to be provided.

F. Comply with manufacturer's printed instructions and recommendations as minimum criteria for the installation of equipment.

G. Where proprietary names are used, whether or not followed by the words "or as approved", they shall be subject to substitution only as approved by the Architect.

H. All materials and equipment provided under this Contract shall be completely satisfactory and acceptable in operation, performance and capacity. No approval, either verbal or written, of any
drawing, descriptive data or samples of such materials, equipment and/or appurtenances, shall relieve this Contractor of his responsibility to turn over all items in perfect working order at completion of the work.

2.2 SUBSTITUTIONS

A. Where the contractor proposes substitute equipment he shall submit complete product data indicating compliance with all requirements of the documents, including performance rating, size and resistance to wear and deterioration equivalent to the specified item at least ten (10) days prior to the bid date. In instances where substituted equipment requires additional material or work beyond that shown or required by the specified item, said additional material or work shall be the responsibility of this Contractor, regardless of the trade involved.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for distinct identification; adequately packaged and protected to prevent damage during shipment, storage and handling.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

3.2 SEQUENCE OF WORK

A. Construct work in a sequence in accordance with Division 1.

3.3 ROUGH-IN

A. Obtain written approval of locations of all electrical devices from the Owner and Architect prior to rough-in. The owner reserves the right to move any or all electrical devices prior to rough-in, at no additional cost.

B. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

C. Refer to equipment specifications in Divisions 2 through 33 for rough-in requirements.

D. Contractor shall obtain detailed and specific information regarding location of all equipment. Final locations may differ from those indicated on drawings. Work improperly placed because
of Contractor's failure to obtain this information shall be relocated and reinstalled as directed, without additional costs to the Contract.

E. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No charges shall be made in location of equipment without prior written approval.

F. Door swings may vary from plans. Make note of actual door swings at time of rough-in. Do not install switches or other items behind the swing of any door.

3.4 INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
10. Coordinate the cutting and patching of building components to accommodate installation of electrical equipment and materials.
11. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
12. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.
13. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Division 26 Section Common Work Results for Electrical.
14. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
3.5 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1. In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
   a. Uncover Work to provide for installation of ill-timed Work.
   b. Remove and replace defective Work.
   c. Remove and replace Work not conforming to requirements of the Contract Documents.
   d. Remove samples of installed Work as specified for testing.
   e. Install equipment and materials in existing structures.
   f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.

2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.

3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

6. Arrange and pay for repairs required to restore other work, because of damage caused as a result of electrical installations.

7. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective or non-conforming installations.

8. Patch all finished surfaces and building components using new materials specified for the original installation and experienced Installers. For installers' qualifications refer to the materials and methods required for the surface and building components being patched.
   a. Refer to Division 1 for definition of experienced "Installer."

3.6 CLEANING

A. Refer to Division 1 for general requirements for final cleaning.

B. Clean all light fixtures, lamps and lenses prior to final acceptance. Replace all inoperative lamps.

3.7 TESTING

A. Contractor, at his own expense, shall make any tests directed by an inspection authority or by the Architect and shall provide all equipment, instruments and materials to make such tests.
B. All overload devices, including equipment furnished under other contracts, shall be set and adjusted to suit load conditions.

C. Unless otherwise approved, all connections shall be made and all components shall be in place, complete and operational, at time of final inspection and tests.

D. Time of such tests, the manner in which they are made and the results of the tests, shall be subject to approval.

E. Upon completion of work, all component parts, both singularly and as a whole, shall be set, calibrated, adjusted and left in satisfactory operating condition to suit load conditions, by means of instruments furnished by the Contractor.

F. Complete testing of equipment and systems shall be provided throughout this project.

G. Industry standards shall apply except as otherwise specified.

H. Provide all labor, premium labor and materials required by shop and field testing as specified in the Contract Documents and as required by the authorities having jurisdiction.

I. Notify the Architect seven (7) days prior to the testing dates. Upon completion of a test, a statement of certification shall be forwarded to the Architect for his approval.

J. Conduct tests at a time agreeable to the Architect. Provide premium labor as necessary.

K. Products which are found defective or do not pass such tests shall be removed and replaced at the Contractor's expense. Tests shall be repeated.

3.8 INSTRUCTIONS TO THE OWNER

A. After the tests and adjustments have been made, approved factory-authorized system representatives and the Contractor shall fully instruct Owner in all details of operation and maintenance of equipment installed under this Contract. Dates and times of such instructions shall be as directed by Owner, including any necessary weekend or after-hours instruction.

B. Additional instruction requirements are included in each section of the Specifications.

C. The Contractor shall video tape and instruction sessions. Prepare a separate video tape for each system as shown on the schedule below. Clearly label the tape with the title “INSTRUCTIONS FOR THE USE OF …”, on both the face and the spine, in typewritten letters. Two (2) copies of each video tape shall be given to the Owner at the completion of the Contract; one (1) set for the maintenance staff and one (1) set for the administrative staff.

D. Prepare an instructional training form indicating the topic of instruction, the date, the time, the purpose of instruction and lines for signatures of attendees. Each person attending the instruction shall print their name and sign the form. Provide a copy of the completed form to the Owner in the O&M manual as proof of instructional training. The Contractor shall keep the original in the Contractor’s project file.
E. The attached schedule indicates the extent of training.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Spec. Sec.</th>
<th>Session 1</th>
<th>Session 2</th>
<th>Session 3</th>
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<td>I 1 M I 4 A - -</td>
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<td>Other Systems not listed above – refer to individual Specification Section</td>
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Notes:
Format: Provide training in the following format:
I = initial meeting to discuss system operation, safety issues, maintenance issues.
1F = follow-up session, 1 month from initial session.
2F = follow-up session, 2 months from initial session.

Length: Provide the length of instruction as follows:
1, 2, 3, etc. indicates the number of hours of training; does not include travel time, setup time, question/answer time.
A/R = as required by Owner or the number of attendees.

Attendees:
A = Administrative Staff, as determined by Owner’s representative.
M = Maintenance Staff, as determined by Owner’s representative.
T = Teaching Staff, schedule multiple sessions to limit instructional session size to 15 people.

Specification Section:
Refer to the individual specification sections for additional training requirements.

END OF SECTION 26 0100
SECTION 26 0200 - ELECTRICAL UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General Terms and Conditions and Division 1 Specifications Sections, apply to work of this section.

1.2 DESCRIPTION

A. The Contractor shall include in the Supplementary Form of Proposal the unit price to be included with the entire light fixture package. Unit prices shall include all material, fittings, accessories, hardware, supports associated with the item.

1.3 UNIT PRICE SCHEDULE

<table>
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PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 26 0200
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SECTION 26 0500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with electrical installations as follows:

1. Selective demolition including:
   a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
   b. Dismantling electrical materials and equipment made obsolete by these installations.

2. Excavation, Backfill, and Restoration.
4. Fire Stopping
5. Access panels and doors in walls, ceilings, and floors for access to electrical materials and equipment.
6. Locations
7. Outages and Disruptions
8. Temporary
9. Scaffolding
10. Painting
11. Vibration Isolation

B. Related Sections: The following sections contain requirements that relate to this section:

1. Division 31 Section “EARTHWORK”, for trenching and backfilling.

1.3 DEFINITIONS

A. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
2. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
3. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
4. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for the following products:
   1. Access panels and doors
   2. Joint sealers
   3. Firestop materials

C. Shop drawings detailing fabrication and installation for metal fabrications and wood supports, and anchorage for electrical materials and equipment.

D. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of work. Include coordination for shut off of electrical service and details for dust and noise control.
   1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section, SUMMARY OF WORK.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer for the installation and application joint sealers, access panels, and doors.

B. Qualify welding processes and welding operators in accordance with AWS D1.1, "Structural Welding Code - Steel."
   1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

C. Fire-resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
   1. Provide UL Label on each fire-rated access door.

D. ASTM E-814 or UL 1479 for firestop system assemblies that provide a fire rating equal to that of construction being penetrated.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code."
F. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the identification of Piping Systems," with regard to type and size of lettering for cable labels.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle joint sealer materials in compliance with the manufacturers' recommendations to prevent their deterioration and damage.

C. Deliver firestop materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand type, and UL label. Store materials under cover and protect from weather and damage. Comply with recommended procedure, precautions and remedies described in material data sheets.

1.7 PROJECT CONDITIONS

A. Conditions Affecting Selective Demolition: The following project conditions apply:

1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services that transit the area affected by selective demolition.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

3. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

4. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.

5. Remove existing underground utilities indicated to be removed.

   a. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.

   b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to Architect prior to utility interruption.
6. Use of explosives is not permitted.

1.8 COORDINATION

A. Coordinate the shut-off and disconnection of electrical service with the Owner and the utility company.

B. Notify the Architect at least 5 days prior to commencing demolition operations.

C. Perform demolition in phases as indicated.

D. Coordinate electrical equipment installation with other building components.

E. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

F. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

G. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

H. Coordinate connection of electrical services with equipment provided under other sections of the specifications.

I. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

J. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces.

K. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

1. Coordinate delivery of firestop materials with scheduled installation date to allow minimum storage at job site.

1.9 INTENT OF DRAWINGS AND SPECIFICATIONS

A. The implied and stated intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable electrical systems complete in every respect.

B. Any apparatus, appliance, material or work not typically shown on drawings as standard industry practice but is mentioned in the specifications, or vice versa, shall be provided by the Electrical Trade without additional expense to the Owner.
C. The drawings are diagrammatic, intending to show general arrangement and location of system components, and are not intended to be rigid in detail.

D. The equipment schedules shown on the drawings list the manufacturer used as the basis of design in the preparation of the Bid Drawings. The equipment specifications list that manufacturer as well as other manufacturers the Engineer, Architect and/or Owner find acceptable from a performance and product quality standpoint. Listing these other manufacturers in no way implies that the Engineer or Architect has exhaustively researched the products available by these manufacturers to determine whether they have a positive or negative monetary impact on the design shown on the Bid Drawings. In addition, listing these other manufacturers in no way implies that the Engineer or Architect has exhaustively researched the products available by these manufacturers to determine whether the dimensions of these products will have a negative impact on the space allotted for this equipment. If the Contractor or their Subcontractors decide to use a product or manufacturer that is listed as acceptable in the specifications but is different from the product or manufacturer scheduled on the drawings, it will be the responsibility of the Contractor or their Subcontractors to fully explore the product to ensure that it can be installed in the space allotted and shall pay any and all costs (including additional professional design fees) associated with the use of these products or manufacturers that impact the structure, the HVAC system(s), the plumbing system(s) and/or the fire protection system(s) due to an increase in weight, electrical load, connection sizes, etc., between the scheduled item and the equipment item used.

1. Use of a product or manufacturer not scheduled on the Bid Drawings constitutes a representation that:
   a. The Electrical Trade has investigated the proposed product and determined that the product can be installed within the space allotted.
   b. The Electrical Trade will coordinate the installation of product used into the work.
   c. The Electrical Trade will be responsible for making all changes as may be required to make the work complete in all respects; waives all claims for additional costs under their responsibility, which may subsequently become apparent.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Provide in accordance with Division 31 Section EARTHWORK for trenching and backfilling.

B. Sub-base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.

C. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2 inch sieve, and not more than 5 percent passing a no. 4 sieve.

D. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than 2 inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.
2.2 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A-36.

B. Cold-formed Steel Tubing: ASTM A-500


E. Non-shrink, Non-metallic Grout: Premixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout, recommended for interior and exterior applications.

F. Fasteners: Zinc-coated, type, grade, and class as required.

2.3 MISCELLANEOUS LUMBER

A. Framing Materials: Standard grade, light-framing-size lumber of any species. Number 3 Common or Standard grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln-dried to a moisture content of not more than 19 percent.

B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

2.4 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Elastomeric Joint Sealers: Provide the following types:

1. One part, mildew-resistant, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and non-porous joint substrates; formulated with fungicide; intended for sealing interior joints with non-porous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

2. Products: Subject to compliance with requirements provide one of the following:

   a. One-part, Mildew-Resistant, Silicone Sealant:

      1) "Dow Corning 786", Dow Corning Corporation
      2) "SCS 1702 Sanitary", General Electric Company
      3) "863 #345 White", Pecora Corporation
      4) "Rhodorsil 6B White", Rhone-Poulenc, Inc.
      5) "Proglaze White", Tremco Corporation
2.5 FIRESTOPPING

A. Acceptable Manufacturers: Subject to compliance with UL requirements, one of the following:
   1. 3M Fire Barrier CP25+
   2. Nelson LBS+
   3. Hilti FS 601 Elastomeric Firestop Sealant
   4. RectorSeal/Metacaulk 1000

B. Use only that manufacturer listed in UL Fire Resistance Directory for the UL system involved.

C. All firestopping materials used on this project shall be the products of one manufacturer. Each trade shall use products of the same manufacturer.

D. Standards: The firestop systems and products shall have been tested in accordance with the procedures of U.L. 1479 (ASTM E814-81) and material shall be UL classified as Fill, Void or Cavity Materials for use in Through-Penetration Firestops. The firestop system shall comply with NEC Paragraph 300-21. All work shall comply with NFPA 101-Life Safety Code, latest edition.

2.6 ACCESS DOORS

A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

B. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
   1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
   2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
   3. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

C. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

D. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

E. Locking Devices: Flush, screwdriver-operated cam locks.

F. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bar-Company, Inc.
   2. J.L. Industries
5. Nystrom, Inc.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with NECA 1.
B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
E. Right of Way: Give to piping systems installed at a required slope.
F. All construction under this contract shall be completed in a neat and craftsmanlike manner. Work that, in the judgement of the Architect, is not satisfactorily installed shall be removed and replaced to the Architect's satisfaction, at the Contractor's expense.
G. Housekeeping: Throughout construction, all work areas and storage areas shall be kept clean. The Contractor shall keep all items clean of dirt, rust, dust and fingermarks.

3.2 SELECTIVE DEMOLITION

A. Examination:
1. Verify field measurements and circuiting arrangements are as shown on Drawings.
2. Verify that abandoned wiring and equipment serve only abandoned facilities.
3. Drawings are based on casual field observation and existing record documents. Report discrepancies to Owner's representative before disturbing existing installation.
4. Beginning of demolition means installer accepts existing conditions.

B. Preparation:
1. Disconnect electrical systems in walls, floors, and ceiling scheduled for removal.
2. Coordinate utility service outages with utility company.
3. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
4. The Contractor shall maintain the operating condition of the existing Fire Alarm System until the new Fire Alarm System is operational. After the new Fire Alarm System has
been installed, tested, inspected, and is fully operational the Contractor shall remove the existing Fire Alarm System completely.

C. Demolition and Extension of Existing Electrical Work:

1. Demolish and extend existing electrical work under provisions of Division 1 and this section.
2. Remove, relocate, and extend existing installations to accommodate new construction.
3. All abandoned wiring shall be disconnected at both ends and removed.
4. Remove exposed, abandoned conduit, including abandoned conduit above accessible ceilings. Cut conduit flush with walls and floors, and patch surfaces.
5. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed.
6. Disconnect and remove abandoned panelboards and distribution equipment.
7. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
8. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.
   a. All spent fluorescent and HID lamps and ballasts shall be disposed of by the contractor according to NEMA guidelines, the Universal Waste Rule, and the requirements of local and state authorities having jurisdiction. The Universal Waste Rule shall only apply to non TCLP conforming lamps.
9. Repair adjacent construction and finishes damaged during demolition and extension work, as approved.
10. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
11. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.
12. Maintain, restore, and provide electrical service for all receptacles, outlets, lighting fixtures and electrically operated equipment not being demolished. Intercept existing circuit, connect new circuiting into existing circuiting and extend new circuiting back to panelboard or previous “up-stream” device, which is not being removed.

D. Disposition of Equipment:

1. Unless specified, indicated, or directed otherwise, all material and equipment not intended for reuse on this project that is to be dismantled or removed under this contract, shall become Contractor's property and shall be transported from the premises by him.
2. Exceptions: Contractor shall remove and transport the following items without damage to an on-site location as directed, for inspection and possible salvage by Owner:
   a. Panelboards and Loadcenters
   b. Lighting Fixtures
   c. Circuit Breakers and Safety Switches
   d. Dimmer Board
   e. Emergency Generator and Accessories
   f. Additional Items as the Owner sees fit during demolition
3. Any and/or all of the foregoing items that Owner may elect not to accept as salvageable materials, shall become Contractor's property and shall be removed from the premises by him.

3.3 EXCAVATION, BACKFILL, AND RESTORATION
A. Provide in accordance with Division 2 Section EARTHWORK.

3.4 SLEEVES AND PENETRATIONS
A. Contractor shall provide sleeves where raceways pass through walls, partitions, floors, and ceilings.

B. Sleeves in bearing and/or masonry walls and/or partitions shall be of galvanized rigid steel conduit finished with smooth edges. For other than masonry or bearing walls/partitions, sleeves shall be EMT conduit.

C. Sleeves in masonry ceilings and floors shall be galvanized rigid steel conduit finished with smooth edges. For other than masonry ceilings and floors, sleeves shall be EMT conduit. All sleeves shall be properly installed and cemented in place.

D. Floor sleeves shall extend 1" above finished floor, unless otherwise noted. Space between floor sleeves and piping or raceway shall be caulked with UL listed fire resistive and waterproof caulking compound as approved.

E. Where piping or raceways pass through waterproofed floors or walls, design of sleeves shall be such that waterproofing can be flashed into and around the sleeves.

F. Where items provided under this Contract pass through roofs this Contractor shall coordinate the installation with the Roofing Contractor and shall provide an approved penetration. The Electrical Contractor shall make provisions not to void the roof bond.

G. Sleeves through exterior walls below grade shall be fitted with seals equal to Thunderline or OZ Type FSK.

3.5 FIRESTOPPING
A. Where conduits, conduit sleeves, wireways and other electrical raceways or cables pass through fire partitions, fire walls, fire floors, or smoke walls, the Electrical Contractor shall provide a fire or smoke stopping that provides an effective barrier against the spread of fire, smoke or gases.

B. Installation of Fire-Stopping Materials: Install materials to fill openings around electrical services penetrating floors and walls and provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Install materials in accordance with printed instructions of the UL Fire Resistance Directory and per manufacturer's published instructions.
C. All cables that are installed in conduit sleeves or in wireways through fire or smoke floors or partitions shall be provided with an equally rated re-enterable U.L. listed fire and smoke rated silicone RTV foam in the opening.

D. Examine fire/smoke-stopped areas to ensure proper installation before concealing or enclosing areas.

E. Keep areas of work accessible until inspection by applicable code authorities.

3.6 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.7 LOCATIONS

A. Obtain written approval of locations of all electrical devices from the Owner and Architect prior to rough-in. The owner reserves the right to move any or all electrical devices prior to rough-in, at no additional cost.

B. Contractor shall obtain detailed and specific information regarding location of all equipment. Final locations may differ from those indicated on Drawings. Work improperly placed because of Contractor's failure to obtain this information shall be relocated and reinstalled as directed, without additional costs to the Contract.

C. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of equipment without prior written approval.

D. Door swings may vary from plans. Take note of actual door swings at time of rough-in. Do not install switches or other items behind the swing of any door.

3.8 OUTAGES AND DISRUPTIONS

A. Continuity of operation of all essential HVAC, plumbing and electrical items, including water, gas, electrical service, lighting, outlets, power and controls for heating and cooling equipment, auxiliary systems, fire alarm, emergency lighting and power, program, sound, alarms and telephones shall be provided as required for occupancy of the premises during the construction period.

B. The schedule and timing of any interruption of water, gas or electrical service or disruption of occupied areas that may affect use of the premises by the Owner, shall be coordinated with the Owner and Architect. Temporary or interim use feeders and facilities shall be provided by the Contractor, as approved and/or directed, to minimize the duration and extent of outages or interruptions.
C. In areas where the construction work will interfere unduly with use of the premises, the Owner may direct that construction work be performed during time periods other than indicated above or on Saturdays, Sundays, or Holidays. Judgment as to whether such undue interference may exist shall rest solely with the Owner. Also, the Owner may require that temporary or interim use feeders and facilities shall be provided by the Contractor as approved and/or directed, to minimize the duration and extent of outages or interruptions.

D. Preparatory work shall be performed as completely as possible in each instance prior to scheduled service outages.

E. Contractor shall be responsible for any and all premium time/overtime required to perform outages and cutovers of services. Coordinate with Owner and Architect.

F. Contractor shall be responsible for any and all premium time/overtime required to complete the work in the various areas within the allotted time, as well as any premium/overtime required to install work through unaffected or remote areas from the work as necessary to maintain continuity of services and occupancy of the existing buildings, as required. Coordinate with Owner and Architect.

3.9 TEMPORARY

A. Temporary Electricity:

1. The Electrical Contractor shall provide temporary electric services to the construction areas at locations acceptable to the General Contractor. The service to be provided shall be from the existing electrical system and shall be 3 phase, 4 wire, 208Y/120V, 100 ampere minimum with the necessary distributing facilities. The service shall be installed within fifteen (15) days after written request has been made to the Electrical Contractor, with copies to the Architect and Owner by any contractor requiring such service.

2. The Electrical Contractor shall provide temporary electric services to the construction trailers at locations acceptable to the General Contractor. The service to be provided shall be from the existing electrical system and shall be 3 phase, 4 wire, 208Y/120V, 100 ampere minimum with the necessary distributing facilities. The service shall be installed within fifteen (15) days after written request has been made to the Electrical Contractor, with copies to the Architect and Owner, by any contractor requiring such service.

3. Power consumption shall not disrupt Owner's need for continuous service. Contractor shall pay for power consumed.

4. The Contractor shall provide power outlets for construction operations, branch wiring, distribution boxes. Each individual contractor will provide flexible power cords as required.

5. Power required for tools and operating equipment used for the installation of equipment, that exceeds the power available, shall be temporarily installed and removed by the Contractor requiring it.

6. Provide wiring and connections for temporary heating equipment required for construction purposes and to prevent building freeze up.

7. Distribution wiring and equipment/devices used for temporary services shall not be installed as part of the permanent building distribution system.

8. Permanent distribution wiring and equipment/devices shall not be used for temporary services.
B. Temporary Lighting:

1. The Contractor shall provide temporary lights and all associated wiring as required by the individual prime contractors.

3.10 SCAFFOLDING

A. The Contractor shall furnish, set, erect, and maintain all scaffolding, aerial equipment and ladders required in the installation of this Contract work.

B. Install temporary platforms so as to be supported only by the existing steel truss framework. Do not allow any additional loading from construction operations to transfer to suspended lath and plaster ceilings.

3.11 PAINTING

A. Except in Mechanical Rooms, Electrical Rooms, and chase spaces all exposed items provided or installed under this Contract shall be painted in accordance with Division 1 requirements.

B. Unless painting is provided by others, as elsewhere specified, all painting for items furnished or installed under this Contract shall be the responsibility of this Contractor.

C. Factory-painted equipment cabinets and trim shall not be field-painted except for touching up scratches or damage where necessary to achieve like-new finish. Touching up shall be done after equipment is in its final location.

D. Paint for metal surfaces shall be Rust-o-leum or as approved, one prime coat and two finish coats of color selected by Architect.

E. Items to be painted shall be cleaned and degreased and shall be free of dirt, rust and corrosion prior to application of paint. All paint shall be applied in accordance with all the manufacturer's recommendations (i.e. temperature, dew point, ventilation).

F. All patchwork performed under this Contract shall be painted. Color shall match the color of adjacent walls, ceilings and floors in which patchwork occurs. Area to be painted shall extend a minimum of 24” all around patchwork; however, final limit shall be set by the Architect. Blend new paint work with existing painted surfaces. Where existing finish is stained or varnished woodwork, all damaged or patched surfaces shall be restored to match the existing adjacent surface, as approved. Paint, stain, varnish and method of application shall be as set out in the specifications for General Construction, or as otherwise approved. Except where painting of patchwork is provided by others, as elsewhere specified, all painting of patchwork required under this Contract shall be the responsibility of this Contractor.

3.12 VIBRATION ISOLATION

A. Isolation mounting shall be provided for all moving equipment where the energy of the vibration is of sufficient magnitude to produce perceptible vibration or structure transmitted noise in occupied areas. Isolation equipment shall be selected, installed and adjusted in accordance with manufacturer's recommendations.
B. All equipment and material shall be installed so as to operate without objectionable noise or vibration as determined by Architect and Owner. Should such objectionable noise or vibration be produced and transmitted to occupied portions of the building by apparatus, piping or other parts of this work, any necessary changes as approved shall be made by the Contractor.

C. All conduit terminations to noise or vibration producing equipment (i.e. motors, transformers) shall be made with a short section of liquidtight flexible metal conduit.
SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference to low voltage electrical power cables specified herein.

C. Requirements of the following Division 26 sections apply to this section:

   1. 26 0500: Common Work Results for Electrical
   2. 26 0533: Raceway and Boxes for Electrical Systems
   3. 26 0534: Cabinets, Boxes, and Fittings

1.2 SUMMARY

A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600 volts and less.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Submittals shall be made with the corresponding equipment/system submittal as complete systems including all required accessories and special installation tools (i.e., termination hardware).

C. Product Data: Submit manufacturer's data for electrical wires, cables and connectors.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following:

   1. NFPA 70 "National Electrical Code"
   2. UL Compliance: Provide components that are listed and labeled by UL under the following standards:

      a. UL Standard 4: Armored Cable.
      b. UL Standard 83: Thermoplastic-Insulated Wires and Cables.
      c. UL Standard 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
3. NEMA/ICEA Compliance: Provide components that comply with the following standards:
   a. WC-5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   b. WC-7: Cross-Linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   c. WC-8: Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   d. WC-30: Color coding of wires and cables.

4. IEEE Compliance: Provide components that comply with the following standards.

5. ETL Compliance: Provide wiring/cabling and connector products that are ETL-listed and labeled.

6. ASTM Compliance: Comply with applicable requirements of ASTM B1, 2, 3, 8 and D-753. Provide copper conductors with conductivity of not less than 98% at 20 degrees C (68 degrees F).

7. FS Compliance: Provide components that comply with the following standards:
   a. J-C-30: Electrical cable and wire (power, fixed, installation)
   b. W-S-610: Splice conductor

1.5 DELIVERY, STORAGE AND HANDLING

A. Each length, bundle, or reel of wire and cable delivered to job site shall bear manufacturer's name, catalog number and trademark, UL label, type letters, size, length and manufacturing date.

B. Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.

C. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris, and traffic.

D. Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of wire, cable, and connector):
1. Wire and Cable:
   a. Alcan Cable Division
   b. American Insulated Wire Corporation
   c. American Wire and Cable Company
   d. General Cable Corporation
   e. Pirelli Cable Corporation
   f. Southwire Company
   g. West Penn Wire Corporation

2. Connectors for Wires and Cable Conductors:
   a. AMP
   b. Thomas and Betts Corporation
   c. Burndy

2.2 BUILDING WIRE
   A. Feeders and branch circuit conductors larger than 10 AWG shall be stranded copper with 600 volt THHN/THWN insulation.
   B. Feeders and branch circuit conductors 10 AWG and smaller shall be solid copper conductor with 600 volt THHN/THWN insulation.
   C. Feeders #2 AWG and above may be compact stranded aluminum.
   D. Type MC (Metal Clad) cable, with copper conductors with 600 volt insulation and green insulated grounding conductor, in sizes #12 AWG and #10 AWG, for branch circuit wiring. MC cable shall be neatly trained and supported clear of ceiling tile and ceiling grid by means of metallic straps or clips. Refer to installation details on drawing E402.
   E. Conductor Material: All conductors, cables and busses shall be copper, 98% conductivity at 20°C (68°F).
   F. Insulation: Provide THHN/THWN insulation for all conductors.
   G. Color Coding for phase identification in accordance with Part 3 below.
   H. Jackets: Factory-applied nylon or PVC external jacketed wires and cables for pulls in raceways over 100 feet in length, for pulls in raceways with more than three equivalent 90 deg. bends, for pulls in conduits underground or under slabs on grade, and where indicated.

2.3 CONNECTORS FOR CONDUCTORS
   A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon that are used.
PART 3 - EXECUTION

3.1 INSTALLATION OF WIRES AND CABLES

A. General: Provide wire and cable suitable for temperature, conditions, and location; and install in compliance with the NEC.

B. Minimum wire size shall be #12 AWG for light and power wiring; #14 for control system wiring.

Exceptions:
1. If the distance between the panelboard and the first circuit load is greater than 100 feet, the minimum wire size shall be #10. All emergency lighting circuit wiring shall be #10 or larger.
2. Conductors and cables for communications and signal systems other than fire alarm system shall be type, size, and insulation as indicated on the drawings, recommended by manufacturer, and approved.
3. Wire for lighting fixtures shall be as called for under Section 265100, and shall comply with NEC.

C. Coordinate wire and cable installation with other work.

3.2 PULLING CONDUCTORS

A. Pull conductors simultaneously where more than one is being installed in same raceway.

B. Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

C. No wires or cable shall be pulled into a raceway until that raceway installation is completed.

D. Only UL approved wire pulling compounds shall be used to decrease friction of pulling in wires.

3.3 SPLICING CONDUCTORS

A. Keep conductor splices to minimum.

B. Install splice and tap connectors that possess equivalent or better mechanical strength and insulation rating than conductors being spliced.

C. Use splice and tap connectors that are compatible with conductor material.

D. Splicing of #10 wires and smaller shall be made with Scotchlok or as approved.

E. Splicing of #8 wire and larger shall be made by means of compression type connectors (AMP, T&B or Burndy) and installed with a proper tool and then insulated to same dielectric value as the original insulation with plastic tape, 3M or equal.

F. Splices are not permitted in conductors larger than #10, except where specifically called for.
G. All splicing shall be made in outlet boxes or junction boxes.

3.4 COLOR CODING

A. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

<table>
<thead>
<tr>
<th>208Y/120Volts Phase</th>
<th>480Y/277 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black A</td>
<td>Yellow</td>
</tr>
<tr>
<td>Red B</td>
<td>Brown</td>
</tr>
<tr>
<td>Blue C</td>
<td>Orange</td>
</tr>
<tr>
<td>White Neutral</td>
<td>Gray</td>
</tr>
<tr>
<td>Green Ground</td>
<td>Green</td>
</tr>
</tbody>
</table>

B. Maintain consistent color coding throughout entire system and phases in order to meet requirements of NEC 210.5(C) identification requirements. Provide engraved placards at every panel, switchboard, and similar distribution equipment indicating the method utilized for phase and system identification.

C. Travelers for 3 way/4 way switches shall be purple.

D. All #12 and #10 branch circuit conductors shall have solid color compound or solid color coating.

E. #8 AWG and larger phase conductors shall have either:
   1. Solid color compound or solid color coating.
   2. Stripes, bands, or hash marks of color specified above.
   3. Colored pressure-sensitive plastic tape. Tape shall be applied in half overlapping turns for a minimum of 3 inches for all terminal points, and in all junction boxes, pull boxes, troughs, manholes, and handholes. Tape shall be 3/4” wide with colors as specified above. The last two laps of tape shall be applied with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.

F. All wiring for communications and signal systems shall be color coded, using black, red, white, yellow, blue and brown with tracers as required. There shall be no two wires of same trace color in the same cable. This color coding shall be consistent and continuous throughout the system.

G. All wiring for fire alarm systems shall be color coded, using orange, yellow, blue and brown with tracers as required. There shall be no two wires of same trace color in the same cable. This color coding shall be consistent and continuous throughout the system.

3.5 TRAINING

A. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than #10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.
3.6 TERMINATIONS

A. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

3.7 CONDUCTOR/CABLE SUPPORT

A. Conductor/cable supports for vertical runs shall be provided in top cabinet or pull box of all feeders in accordance with NEC requirements. Cable supports shall be O.Z. Electrical Mfg. Company, or as approved.

3.8 NEUTRAL CONDUCTORS

A. Provide dedicated neutrals for all single phase branch circuits.

B. 15, 20, and 30 ampere branch circuit conductors of different phases may share a neutral conductor to the extent permitted by NEC. If Contractor chooses to share neutrals, contactor shall provide multi-pole breakers in panels in lieu of single pole breakers indicated on schedules in order to meet requirements of NEC 210.4. Responsibility for this coordination rests solely with the Contractor.

Exceptions:

1. Provide separate neutral conductors for each branch circuit phase conductor serving dimming equipment, HID ballasts, or computer outlets and as indicated on the drawings.

3.9 PHASE BALANCING

A. The system of feeder and branch circuits for lighting and power shall be connected to panelboard busses in such a manner that loads connected thereto will be balanced on all phases as closely as practicable. If the difference of balance on any part of electrical system exceeds 15%, the Contractor shall make such changes as directed to achieve optimum balance.

3.10 FIELD QUALITY CONTROL

A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.

B. Prior to energizing, test wires and cables for electrical continuity and for short-circuits.

C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

END OF SECTION 26 0519
SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference to grounding specified herein.

C. Requirements of the following Division 26 Sections apply to this Section:
   1. 26 0100: Basic Electrical Requirements.
   2. 26 0500: Common Work Results for Electrical
   3. 26 0519: Low Voltage Electrical Power Cables.

1.2 SUMMARY

A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

   1. Product data for ground rods, connectors, connection materials, and grounding fittings.
   2. Field-testing organization certificate, signed by the Contractor, certifying that the organization performing field tests complies with the requirements specified in Quality Assurance below.
   3. Report of field tests and observations certified by the testing organization.

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for project.
C. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.

1. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. Field-Testing Organization Qualifications: To qualify for acceptance, the independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code" (NEC).

F. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical grounding and bonding.

G. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

PART 2 - PRODUCTS

2.1 EXOTHERMIC WELDING

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cadweld
2. Thermoweld

B. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

C. Field Welding: Comply with AWS Code for procedures, appearance, and quality of welds; and methods used in correcting welding work. Provide welded connections where grounding conductors connect to underground grounding rods/electrodes.

2.2 GROUNDING AND BONDING PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. B-Line Systems Inc.
2. Burndy Corporation
3. Crouse-Hinds Company
4. Electrical Components Div; Gould Inc.
5. General Electric Supply Company
6. Ideal Industries, Inc.
7. Thomas and Betts Corporation
8. Western Electric Company
B. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

C. Conductor Materials: Copper with 98% conductivity.

2.3 WIRE AND CABLE CONDUCTORS

A. General: Comply with Division 26 Section "Low Voltage Electrical Power Cables"

B. Equipment Grounding Conductor: Green insulated.

C. Grounding Electrode Conductor: Stranded cable.

D. Bare Copper Conductors: Conform to the following:

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

2.4 MISCELLANEOUS CONDUCTORS

A. Ground Bus: Bare annealed copper bars of rectangular cross section.

B. Copper Bonding Conductors: As follows:
   1. Bonding Cable: 28kcmil, 14 strands of No. 17 AWG copper conductor, ¼ inch (6.4 mm) in diameter.
   2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
   3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
   4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

C. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.

D. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

E. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gage bare copper wire; 3/4" wide, 9-1/2" long; 48,250 cm. Protect braid with copper bolt hole ends with holes sized for 3/8" dia. bolts.
2.5 CONNECTOR PRODUCTS
A. General: Listed and labeled as grounding connectors for the materials used.
B. Pressure Connectors: High-conductivity-plated units.
C. Bolted Clamps: Bolted pressure type connectors, or compression type. Heavy-duty units listed for the application.
D. Aluminum-To-Copper Connections: Bimetallic type, conforming to UL 96, "Lightning Protection Components," or UL 467.
E. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer’s written instructions

2.6 GROUNDING ELECTRODES
A. Ground Rods: Copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core.
   1. Size: 3/4 inch by 10 feet.
B. Signal and Communications: For telephone, alarms, and communication systems, provide a #4 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each terminal cabinet or central equipment location.
C. Bonding Plates, Connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.
D. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.1 GENERAL
A. Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.
3.2 INSPECTION

A. Installer must examine areas and conditions under which electrical grounding connections are to be made and notify the Architect in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

3.3 APPLICATION

A. Provide electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

B. Provide a green insulated grounding conductor sized in accordance with NEC Table 250-122 in all raceways and cables where the conductor overcurrent protection is 15 AMPS or larger.

C. Separately derived systems required by NEC to be grounded shall be grounded in accordance with NEC paragraph 250-66.

D. Metal Poles Supporting Outdoor Lighting Fixtures: Ground pole to a grounding electrode as indicated in addition to separate equipment grounding conductor run with supply branch circuit.

E. Connections to Lightning Protection System: Bond grounding conductors or grounding conductor conduits to lightning protection down conductors or grounding conductors in compliance with NFPA 780 "Lightning Protection Code."

F. Common Ground Bonding With Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system ground conductor and installed in conduit.

G. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

H. Grounding Bus: Install in electrical equipment rooms in designated location for connection to communication system grounding by Division 27 Contractor.

1. Use insulated spacer; space 1 inch (25.4 mm) from wall.

I. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade or bury 12 inches (300 mm) above duct bank when installed as part of the duct bank.

J. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

K. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

L. Nonmetallic Raceway: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
M. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

3.4 INSTALLATION

A. General: Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.

B. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.

C. Ground Rods: Locate a minimum of one-rod length from each other and at least the same distance from any other grounding electrode. Interconnect ground rods with bare conductors buried at least 24 inches below grade. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated. Make these connections without damaging the copper coating or exposing the steel. Use 3/4-inch by 10-ft. ground rods except as otherwise indicated. Drive rods until tops are 6 inches below finished floor or final grade except as otherwise indicated.

D. Metallic Water Service Pipe: Provide insulated copper ground conductors, sized as indicated, from the building main service equipment, or the ground bus, to main metallic water service entrances to the building. Connect ground conductors to the main metallic water service pipes by means of ground clamps. Where a dielectric main water fitting is installed, connect the ground conductor to the street side of the fitting. Do not install a grounding jumper around dielectric fittings.

E. Braided-Type Bonding Jumpers: Install to connect ground clamps on water meter piping to bypass water meters electrically. Use elsewhere for flexible bonding and grounding connections.

F. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

G. Bond interior metal piping systems and metal air ducts to equipment ground conductors of pumps, fans, electric heaters, and air cleaners serving individual systems.

H. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

I. Bond each above ground portion of gas piping system upstream from equipment shutoff valve.
3.5 CONNECTIONS

A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
2. Make connections with clean bare metal at points of contact.
3. Aluminum to steel connections shall be with stainless steel separators and mechanical clamps.
4. Aluminum to galvanized steel connections shall be with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

B. Exothermic Welded Connections: Use for connections to structural steel and for underground connections except those at test wells. Install at connections to ground rods and plate electrodes. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.

D. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A.

E. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.

3.6 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Handholes: Install a 3/4-inch by 10-ft. driven ground rod close to the wall and set the rod depth such that 4 inches will extend above the finished floor. Where necessary, install ground rod before the manhole is placed and provide a No. 1/0 bare tinned-copper conductor from the ground rod into the manhole through a waterproof sleeve in the manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below the concrete. Seal floor opening with waterproof nonshrink grout.

B. Grounding System: Ground non-current-carrying metallic items associated with pad-mounted equipment by connecting them to bare underground cable and grounding electrodes arranged as indicated.
C. Duct Banks: Install a grounding conductor with at least 50 percent ampacity of the largest phase conductor in the duct bank.

D. Pad-Mounted Transformers: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches (450 mm) below grade and 6 inches (150 mm) from the foundation.

3.7 FIELD QUALITY CONTROL

A. Upon Completion of installation of electrical grounding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 3 ohms, take appropriate action to reduce resistance to 3 ohms, or less, by driving additional ground rods and/or by chemically treating soil encircling ground rod; then retest to demonstrate compliance.

B. Independent Testing Organization: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below.

C. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground resistance level is specified, at service disconnect enclosure ground terminal, and at ground test wells. Measure ground resistance without the soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method in accordance with Section 9.03 of IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System."

D. Ground/resistance maximum values shall be as follows:
   1. Equipment rated 500 kVA and less: 10 Ohms
   2. Equipment rated 500 kVA to 1000 kVA: 5 Ohms
   3. Equipment rated over 1000 kVA: 3 Ohms

E. Deficiencies: Where ground resistances exceed specified values, and if directed, modify the grounding system to reduce resistance values. Where measures are directed that exceed those indicated the provisions of the Contract, covering changes will apply.

F. Report: Prepare test reports, certified by the testing organization, of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.8 CLEANING AND ADJUSTING

A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition.
SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference to hangers and supports specified herein.

C. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0100: Basic Electrical Requirements.  
   2. 26 0500: Common Work Results for Electrical

1.2 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. All supports shall utilize threaded fasteners for all connections/attachments. The use of clips or clip-on type supports is not acceptable.

C. Types of supports, anchors, sleeves and seals specified in this section include but are not limited to the following:
   1. Clevis hangers
   2. Riser clamps
   3. C-clamps
   4. I-beam clamps
   5. One-hole conduit straps
   6. Two-hole conduit straps
   7. Round steel rods
   8. Lead expansion anchors
   9. Toggle bolts
   10. Wall and floor seals

D. Supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly in other Division 26 sections.

E. Related Sections: The following Section contains requirements that relate to this Section:
   1. Refer to other Division 26 sections for additional specific support requirements that may be applicable to specific items.
1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

1. Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve and seal.
2. Shop Drawings: Submit dimensioned drawings of fabricated products, indicating details of fabrication and materials.

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical supporting device work similar to that required for this project.

C. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.

D. MSS Compliance: Comply with applicable MSS standard requirements pertaining to fabrication and installation practices for pipe hangers and supports.

E. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

F. UL Compliance: Provide electrical components that are UL listed and labeled.

G. FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe, and cable.

H. Electrical components shall be listed and labeled by ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Slotted Metal Angle and U-Channel Systems:
   a. Allied Tube & Conduit
   b. American Electric
   c. B-Line Systems, Inc.
   d. Cinch Clamp Company, Inc.
ADDITIONS AND ALTERATIONS
QUAKER VALLEY MIDDLE SCHOOL
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
QUAKER VALLEY SCHOOL DISTRICT

2. Anchors:
   a. Abbeon Cal Inc.
   b. Ackerman Johnson Fastening Systems Inc.
   c. Elcen Metal Products Company
   d. Ideal Industries, Inc.
   e. Joslyn Mfg and Supply Company
   f. McGraw Edison Company
   g. Rawl Plug Company Inc.
   h. Star Expansion Company
   i. U.S. Expansion Bolt Company
   j. Hilti, INC.

3. Conduit Sealing Bushings:
   a. Bridgeport Fittings, Inc.
   b. Cooper Industries, Inc.
   c. Elliott Electric Mfg. Corporation
   d. GS Metals Corporation
   e. Killark Electric Mfg. Company
   f. Madison Equipment Company
   g. L.E. Mason Company
   h. O-Z/Gedney
   i. Producto Electric Corporation
   j. Raco, Inc.
   k. Red Seal Electric Corporation
   l. Spring City Electrical Mfg. Company
   m. Thomas & Betts Corporation

2.2 U-CHANNEL STRUT SYSTEMS

A. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16” diameter holes, 8” o.c. on top surface, with standard green finish, and with the following fittings that mate and match with U-channel and are of the same manufacturer:

1. Fixture hangers
2. Channel hangers
3. End caps
4. Beam clamps
5. Wiring stud
6. Thin wall conduit clamps  
7. Rigid conduit clamps  
8. Conduit hangers  
9. U-bolts  

2.3 SUPPORTING DEVICES  

A. Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

1. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 1/2" diameter hole for round steel rod; approximately 54 pounds per 100 units.  
2. Riser Clamps: For supporting 5" rigid metal conduit; black steel; with 2 bolts and nuts; and 4" ears; approximately 510 pounds per 100 units.  
3. Reducing Couplings: Steel rod reducing coupling 1/2" x 5/8"; black steel; approximately 16 pounds per 100 units.  
4. C-Clamps: Black malleable iron; 1/2" rod size' approximately 70 pounds per 100 units.  
5. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock, 3/8" cross bolt; flange width 2"; approximately 52 pounds per 100 units.  
6. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approximately 7 pounds per 100 units.  
7. Two-Hole Conduit Straps: For supporting 3/4" rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.  
8. Hexagon Nuts: For 1/2" rod size; galvanized steel; approximately 4 pounds per 100 units.  
9. Round Steel Rod: Black steel; 1/2" dia.; approximately 67 pounds per 100 feet.  
10. Offset Conduit Clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 pounds per 100 units.

B. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.  

C. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.  

D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.  

2.4 ANCHORS  

A. Provide anchors of types, sizes and materials indicated; and having the following construction features:

1. Lead Expansion Anchors: 1/2", approximately 38 pounds per 100 units.  
2. Toggle Bolts: Springhead; 3/16" x 4"; approximately 5 pounds per 100 units.  
3. Expansion Anchors: Carbon-steel wedge or sleeve type.  
4. Toggle Bolts: All-steel springhead type.  
2.5 CHANNEL SUPPORTS

A. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.

B. Slotted-Steel Channel Supports: Comply with Division 5 Section "Metal Fabrications" for slotted channel framing.
   1. Channel Thickness: Selected to suit structural loading.
   2. Fittings and Accessories: Products of the same manufacturer as channel supports.

C. Nonmetallic Channel and Angle Systems (wet locations): Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least one surface.
   1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
   2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

2.6 SLEEVES AND SEALS

A. Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:
   1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
   2. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

2.7 CABLE SUPPORTS FOR VERTICAL CONDUIT

A. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

2.8 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.
2.9  FABRICATED SUPPORTING DEVICES

A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
   a. 3-inch and smaller: 20-gage.
   b. 4-inch to 6-inch: 16-gage.
   c. over 6-inch: 14-gage.

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Iron Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.
5. Sleeve Seals: Provide sleeve seals for piping that penetrates foundation walls below grade, or exterior walls. Provide Firestopping in accordance with section 260500. As a minimum caulk between sleeve and pipe with non-toxic, UL classified caulking material to ensure watertight seal.
6. Sleeve Seals: Provide modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates that cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.10  CONCRETE WORK

A. Unless indicated otherwise, concrete used in construction of envelopes, encasements, equipment pads, manhole and duct structures shall be 3000 pound proportions except for concrete pads for reciprocating equipment foundations, that shall be 3300 pound minimum. No concrete tests are required unless otherwise indicated.

B. All reinforcement bars shall conform to ASTM Standards and be provided in quantity and of sizes shown on drawings or specified herein.

PART 3 - EXECUTION

3.1  GENERAL

A. Provide supporting devices that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.
B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installations of supporting devices.

C. Coordinate with the building structural system and other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

D. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacings indicated and in compliance with NEC requirements.

E. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

F. Obtain approval from the Architect before drilling or cutting structural members.

G. Install surface-mounted cabinets and panelboards with minimum of four anchors.

H. In wet and damp location use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.

I. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

3.2 EQUIPMENT FOUNDATIONS

A. Unless otherwise indicated, construction of all concrete equipment foundations required for equipment furnished under Division 26 of specifications shall be this Contractor's responsibility. Foundations shall be sufficient size to suit equipment furnished, as approved.

B. All exposed surfaces, except those that have steel protection, shall be finished with cement mortar, troweled smooth, with chamfered corners.

3.3 RACEWAY SUPPORTS

A. Comply with the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 3/4” raceways above suspended ceilings. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

6. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with NEC.

7. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

3.4 CABLE SUPPORTS FOR VERTICAL CONDUIT

A. Install simultaneously with installation of conductors.

3.5 IN OPEN OVERHEAD SPACES

A. Support boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

3.6 MISCELLANEOUS

A. Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

B. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Torque sleeve seal nuts in accordance with manufacturers recommended values to ensure that sealing grommets expand to form a watertight seal.

3.7 FASTENING

A. Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts, or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
2. Holes cut into reinforced concrete beams or in concrete shall not cut reinforcing bars. If the Contractor cuts into any reinforcing bars, stop work and notify the Architect immediately. Fill holes that are not used.
3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

3.8 TESTS

A. Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors.
2. Toggle bolts.

B. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.
## SPACING FOR RACEWAY SUPPORTS

<table>
<thead>
<tr>
<th>Raceway Size (Inches)</th>
<th>No. of Conductors in Run</th>
<th>Location</th>
<th>Maximum Spacing of Supports (Feet) RMC&amp;IMC*</th>
<th>EMT</th>
<th>RNC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HORIZONTAL RUNS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1/2, 3/4</td>
<td>1 or 2</td>
<td>Flat ceiling or wall</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>1/2, 3/4</td>
<td>1 or 2</td>
<td>Where it is difficult to provide supports except at intervals fixed by the building construction</td>
<td>7</td>
<td>7</td>
<td>...</td>
</tr>
<tr>
<td>1/2, 3/4</td>
<td>3 or more</td>
<td>Any location</td>
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<td>7</td>
<td>...</td>
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<tr>
<td>1/2-1</td>
<td>3 or more</td>
<td>Any location</td>
<td>7</td>
<td>7</td>
<td>...</td>
</tr>
<tr>
<td>1 &amp; larger</td>
<td>1 or 2</td>
<td>Flat ceiling or wall</td>
<td>6</td>
<td>6</td>
<td>...</td>
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<tr>
<td>1 &amp; larger</td>
<td>3 or more</td>
<td>Where it is difficult to provide supports except at intervals fixed by the building construction</td>
<td>10</td>
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<td>Any</td>
<td>3 or more</td>
<td>Any location</td>
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<td>Any</td>
<td>...</td>
<td>Concealed</td>
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<tr>
<td><strong>VERTICAL RUNS</strong></td>
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<td>1/2, 3/4</td>
<td>...</td>
<td>Exposed</td>
<td>7</td>
<td>7</td>
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</tr>
<tr>
<td>1, 1-1/4</td>
<td>...</td>
<td>Exposed</td>
<td>8</td>
<td>8</td>
<td>...</td>
</tr>
<tr>
<td>1-1/2 &amp; larger</td>
<td>...</td>
<td>Exposed</td>
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</tr>
<tr>
<td>Up to 2</td>
<td>...</td>
<td>Shaftway</td>
<td>14</td>
<td>10</td>
<td>...</td>
</tr>
<tr>
<td>2-1/2</td>
<td>...</td>
<td>Shaftway</td>
<td>16</td>
<td>10</td>
<td>...</td>
</tr>
<tr>
<td>3 &amp; larger</td>
<td>...</td>
<td>Shaftway</td>
<td>20</td>
<td>10</td>
<td>...</td>
</tr>
<tr>
<td>Any</td>
<td>...</td>
<td>Concealed</td>
<td>10</td>
<td>10</td>
<td>...</td>
</tr>
</tbody>
</table>

* Maximum spacings for IMC above apply to straight runs only. Otherwise the maximums for EMT apply.

**Abbreviations:**
- EMT: Electrical metallic tubing.
- IMC: Intermediate metallic conduit.
- RMC: Rigid metallic conduit.
- RNC: Rigid nonmetallic conduit.

**END OF SECTION 26 0529**
SECTION 26 0533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference to raceways specified herein.

C. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0100: Basic Electrical Requirements
   2. 26 0500: Common Work Results for Electrical
   3. 26 0529: Hanger and Supports for Electrical Systems
   4. 26 0533: Raceway and Boxes for Electrical Systems
   5. 26 0534: Cabinets, Boxes, and Fittings
   6. 26 0553: Identification for Electrical Systems
   7. 26 2726: Wiring Devices
   8. 26 2816: Enclosed Switches and Circuit Breakers

1.2 SUMMARY

A. This Section includes raceways for electrical wiring. Types of raceways in this section include the following:
   1. Electrical metallic tubing (EMT).
   2. Flexible metal conduit.
   3. Intermediate metal conduit.
   4. Liquidtight flexible conduit.
   5. Underground plastic utilities duct.
   6. Rigid metal conduit.
   7. Rigid nonmetallic conduit.
   8. Surface raceways.
   9. PVC externally coated rigid steel conduit.
  10. Electrical nonmetallic tubing.
  11. Wireway.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Product Data for the following products:

   1. Conduit and fittings.
2. Wireway and fittings.
3. Surface Mounted Raceway

C. Samples, 6 inches long of each type and size of surface raceway, with required finish.

D. Installation Instructions: Manufacturer's written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate with other Work, including metal and concrete deck installation, as necessary to interface installation of electrical raceways and components with other Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Metallic Conduit and Fittings:
   a. Allied Tube
   b. Wheatland Tube
   c. Western Tube
   d. Republic Conduit

2. Non-Metallic Conduit and Fittings:
   a. Allied Tube
   b. Carlon/T&B
   c. Cantex
   d. J&M

3. Wireway:
   a. Hoffman
2.2  STANDARDS

A. All raceways shall be UL approved for usage intended and each length delivered to the job site shall bear UL manufacturer's label.

B. Rigid Metal Conduit (RMC): Threaded type conforming to FS WW-C-581, ANSI C80.1, and UL 6 with zinc coating fused to inside and outside walls.

1. PVC Externally Coated Rigid Steel Conduit: Rigid steel zinc-coated with additional external coating of PVC conforming to ANSI C80.1 and NEMARN 1.
2. Rigid Metal Conduit Fittings: Cast steel, galvanized or cadmium plated, conforming to FS W-F-408.
   a. RMC fittings shall be threaded.
   b. Raintight connections for all fittings exposed to water.
   c. Concrete tight connections for all fittings in concrete.

C. Intermediate Steel Conduit (IMC): Rigid intermediate grade electro-galvanized conforming to FS WW-C-581 and UL 1242.

1. Intermediate Conduit Fittings: Cast steel, galvanized or cadmium plated, conforming to FS W-F-408.
   a. IMC fittings shall be threaded.
   b. Raintight connections for all fittings exposed to water.
   c. Concrete tight connections for all fittings in concrete.

D. Electrical Metallic Tubing (EMT): FS WW-C-563, ANSI C80.3 and UL 797.

1. EMT Fittings: FS W-F-408.
   a. EMT fittings shall be steel, compression type.
   b. Raintight connections for all fittings exposed to water.
   c. Concrete tight connections for all fittings in concrete.

E. Flexible Metal Conduit: FS WW-C-566 and UL 1. Formed from continuous length of spirally wound interlocked zinc-coated strip steel.

1. Flexible Metal Conduit Fittings: For use with flexible steel conduit of threadless hinged clamp type.
a. Straight Terminal Connectors: One piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

b. 45° or 90° Terminal Angle Connectors: Two piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

F. Liquid-tight Flexible Metal Conduit: Constructed of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinylchloride (PVC) conforming to UL 360.

1. Liquid-tight Flexible Metal Conduit Fittings: FS W-F-406, Type 1, Class 3, Style G. Provide cadmium plated, steel fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated, or non-insulated throat.

G. Non-metallic Conduit and Ducts:

1. Rigid Non-metallic Conduit (RNC): Schedule 40 or 80 PVC conforming to NEMA TC-2, UL651 and NEC Article 347 for direct burial or normal above-grade use.
2. PVC Conduit and Tubing Fittings: NEMA TC 3, NEMA RN 1; match to conduit or conduit/tubing type and material.
3. Liquidtight Flexible Nonmetallic Conduit and Fittings: UL 1660. Fittings shall be specifically approved for use with this raceway.
4. Conduit, Tubing, and Duct Accessories: Types, sizes, and materials complying with manufacturer's published product information. Mate and match accessories with raceway.

H. Conduit, Tubing and Duct Accessories:

1. Provide conduit, tubing, and duct accessories of types, sizes, and materials, complying with manufacturer's published product information, that mate and match conduit and tubing.

I. Conduit Bodies:

1. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.
2. Conduit Bodies 1 Inch and Smaller: Use bodies with compression-type EMT connectors.
3. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.

J. Wireways:

1. General: Electrical wireways shall be of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC.
2. Wireway covers shall be hinged type.
K. Surface Raceways:

1. General: Sizes and channels as indicated. Provide fittings that match and mate with raceway.
2. Surface Metal Raceway: Construct of galvanized steel with snap-on covers, with 1/8-inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for painting. Provide finish coat of paint as directed by the Architect. Provide raceways of types suitable for each application required.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide conduit, tubing, duct and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection to fulfill wiring requirements, and comply with applicable portions of NEC for raceways.

3.2 WIRING METHODS

A. Underground Raceway:

1. Polyvinylchloride (PVC) Schedule 40, except where Schedule 80 is noted, required by code or required by the utility company. Provide 4" minimum overall concrete encasement for PVC conduit.
2. Galvanized Rigid Steel, factory PVC coated, installed without concrete envelope.
3. Wherever non-metallic raceways are installed under roadways (meaning any areas intended for use by vehicles), concrete encasement shall be reinforced with a minimum of four No. 4 reinforcing steel rods spaced 2" in from each corner. Reinforcing rods shall extend continuously throughout the width of the raceway so as to preclude raceway shear.
4. In all cases, raceways shall be nested, packaged and supported on approved supports prior to concrete pour or backfill.
5. Where underground runs 2" and larger end in a 90 degree bend and a vertical riser conduit, the 90 degree bend and the riser conduit shall be rigid metal conduit, except where PVC is specifically required by the utility company, in which case, Schedule 80 PVC shall be used.
6. Joints or couplings shall be made watertight.
7. Raceways shall be man-drilled after installation to insure against any possible obstructions.
8. Underground raceways shall be installed at a minimum depth of 3'-0" below finished grade to top of raceway, or lower if so required by code, utility company, or drawing details.
9. Where underground raceways are installed for electrical systems operating at 1,000 volts or greater, underground raceways shall be field heated and bent, with a minimum radius of 10 feet.
10. Provide yellow plastic marking tape, Seton or equivalent, 3" in width and lettered electrical lines below, 18" above all underground raceways.
B. Embedded Raceway:

1. Raceway installed in floor slabs shall be galvanized rigid metal conduit.
2. Raceways embedded in slabs: Install in middle third of the slab thickness where practical and leave at least 1 inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run conduit, larger than 1 inch trade size, parallel with, or at right angles to, the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit or tubing is used, raceways must be converted to Schedule 80 or rigid steel conduit or tubing IMC before rising above floor.
3. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
4. Stub-up Connection: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.

C. Indoor Raceway:

1. Provide continuous metallic raceways, minimum 3/4" trade size, for all conductors except as indicated in the following paragraphs:
   a. Except where otherwise prohibited by applicable codes, conductors and cables operating at less than 30 volts and having "plenum type" insulation listed for compliance with NEC Article 300-22(c) are acceptable installed without raceways above accessible suspended acoustic ceilings unless indicated otherwise on the contract drawings. Accessible suspended ceilings are defined as those having access panels, unsplined tiles for access purposes, unclipped lay-in tiles for access purposes, or other approved access means at intervals of not more than 20 feet from one another.
   b. Where conductors or cables are installed in compliance with the above, the cables shall be neatly supported clear of the ceiling system by means of approved preformed nylon tie devices. Supports shall be accessible. Maintain a minimum spacing of 18" between parallel runs of sound system wiring and wiring of other systems. Maintain a minimum spacing of 18" between parallel runs of television system wiring, microphone wiring and wiring of other systems.
   c. Type MC (metal clad) as permitted by Section 260519.
   d. Unless otherwise approved, raceways in all locations shall be zinc-coated electrical metallic tubing (EMT) except:
      1) Where shown or specified otherwise, or as otherwise required by NEC.
      2) Nipples shorter than 6" shall be galvanized rigid metal conduit.
      3) Raceways in Kitchens shall be IMC.
      4) Raceways in damp or wet locations as defined by NEC shall be galvanized rigid steel or intermediate grade conduit installed watertight with watertight fittings and threaded hub cast alloy boxes having gasketed covers.
2. All raceways for electrical system operating at 1000 volts or greater shall be rigid metallic conduit. All bends and sweep ells shall be a minimum of 4 feet radius unless noted otherwise.

D. Flexible Connections:

1. Use flexible metallic conduit for final connection to recessed and semi-recessed lighting fixtures, not to exceed 48".
2. Use flexible metallic conduit for final connection to motors, transformers, and equipment subject to vibration, noise transmission, or movement.
3. Use liquid-tight flexible metallic conduit where subjected to one or more of the following conditions:
   a. Exterior Location
   b. Moist, humid atmosphere where condensate can be expected to accumulate.
   c. Subjected to water spray or dripping oil, water or grease.

E. Raceways and associated items shall be installed concealed except for the following areas and locations where surface installation is acceptable:

1. Boiler Rooms
2. Electrical Equipment Rooms
3. Mechanical Equipment Rooms
4. Elevator Equipment Rooms
5. Crawl Spaces
6. Vertically above and below surface mounted panelboards
7. Surface metal raceway, where indicated or approved
8. Multi-outlet assembly, where indicated or approved
9. Where concealed work is shown or required by specifications in locations where construction is completed, Contractor shall provide cutting, chasing, patching and restoring of surface as necessary to provide the concealed installation.

F. Surface Metal Raceway:

1. Surface metal raceway, where shown, specified or approved, shall be equal to Wiremold 700 (or 2000, 3,000, 4,000, or 2,200 if so noted or if conductor fill so requires) shall be complete with manufacturer's factory fabricated fittings throughout and shall be secured on not greater than 48" centers.

3.3 INSTALLATIONS

A. General: Install electrical raceways in accordance with manufacturer's written installation instructions, applicable requirements of NECA's "Standards of Installation" and as follows:

B. Under no conditions shall raceways be run exposed on floors.

C. Conceal Conduit and EMT, unless indicated otherwise, within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
D. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.

E. Complete installation of electrical raceways before starting installation of conductors within raceways.

F. Provide supports for raceways as specified elsewhere in Division 26.

G. Prevent foreign matter from entering raceways by using temporary closure protection.

H. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

I. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.

J. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated. This does not apply to conduits in crawl spaces.

K. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.

L. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases provide field bends for parallel raceways.

M. Join raceways with fittings designed and approved for the purpose and make joints tight. Make raceway terminations tight.

N. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity.

O. Where subject to vibration or dampness, use insulating bushings to protect conductors.

P. The complete wiring system shall be continuously grounded from service entrance to all outlets.

Q. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.

R. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

S. Install pull wires in all empty raceways. Use no. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.
T. Telephone and Signal System Raceways 2-Inch Trade Size and Smaller: In addition to the above requirements, install raceways 2-inch and smaller trade size in maximum lengths at 150 feet and with a maximum of two, 90-deg bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.

U. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:

1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
2. Where required by the NEC.

V. Do not install aluminum conduit embedded in or in contact with concrete.

W. PVC externally coated rigid steel conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.

X. Provide expansion fittings for conduit as recommended by the manufacturer where conduit is run exterior to the building or is subject to changes in temperature. As a minimum for external conduit, provide one expansion fitting every 100 feet for steel conduit and one expansion fitting every 50 feet for aluminum conduit.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.5 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 ADJUSTING AND CLEANING

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

END OF SECTION 26 0533
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SECTION 26 0534 - CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference to cabinets, boxes, and fittings specified herein.

C. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0100: Basic Electrical Requirements
   2. 26 0500: Common Work Results for Electrical

1.2 SUMMARY

A. This section includes cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other sections. Types of products specified in this Section include:
   1. Outlet and device boxes.
   2. Pull and junction boxes.
   3. Floor boxes and service fittings.
   5. Hinged door enclosures.

B. Conduit-body-type electrical enclosures and wiring fittings are specified in Division 260533.

1.3 DEFINITIONS

A. Cabinets: An enclosure designed either for surface or for flush mounting and having a frame or trim in which a door or doors may be mounted.

B. Device Box: An outlet box designed to house a receptacle device or a wiring box designed to house a switch.

C. Enclosure: A box, case, cabinet, or housing for electrical wiring or components.

D. Hinged Door Enclosure: An enclosure designed for surface mounting and having swinging doors or covers secured directly to the walls of the box.

E. Outlet Box: A wiring enclosure where current is taken from a wiring system to supply utilization equipment.
F. Wiring Box: An enclosure designed to provide access to wiring systems or for the mounting of indicating devices or of switches for controlling electrical circuits.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

B. Shop drawings for floor boxes and boxes, enclosures and cabinets that are to be shop fabricated, (non-stock items). Show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.

1.5 QUALITY ASSURANCE

A. Nationally Recognized Testing Laboratory Listing and Labeling (NRTL): Items provided under this section shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

B. National Electrical Code Compliance: Components and installation shall comply with NFPA 70 "National Electrical Code."

C. UL Compliance: Comply with applicable requirements of UL 50, UL 514 Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings that are UL listed and labeled.

D. NEMA Compliance: Comply with applicable requirements of NEMA Standards/Pub No.'s 0S1, 0S2, FB 1, and Pub 250 pertaining to outlet and device boxes, covers and box supports.

E. Federal Specification Compliance: Comply with applicable requirements of FS W-C-586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies and Entrance Caps".

PART 2 - PRODUCTS

2.1 CABINETS, BOXES, AND FITTINGS - GENERAL

A. Provide Electrical Cabinets, Boxes, and Fittings of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

2.2 OUTLET AND DEVICE BOXES

A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application.
B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.

C. Cast-Iron Boxes: Conform to NEMA FB 1. Iron alloy, Type FD, waterproof, with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

D. Outlet Boxes: Provide galvanized flat rolled sheet steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Provide outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

E. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, that are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliant option.

F. Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.

G. Non-metallic Floor Boxes: Waterproof with raceway entrances, adjusting rings, gaskets, and brass floor plates. Where indicated, provide multi-section boxes with individual hinged section covers and provide for a duplex receptacle under one or more of the covers. Once installed, Contractor shall cut remaining material above concrete slab so that box is flush with top of concrete.

H. Steel Floor Boxes: Sheet steel, concrete tight, fully adjustable, with stamped knockouts, adjusting rings, and brass floor plates. Where indicated, provide multi-section boxes with concealed individual section covers under a common flush floor plate. Provide for a duplex receptacle in one of the concealed section covers and a bushed opening(s) for telephone or other communications service, as indicated, in the other.

I. Service Fittings for Floor Outlet Boxes: Surface mounted horizontal, cast aluminum type 3-inches high, suitable for finished spaces and finished in satin aluminum, except as otherwise indicated. Provide duplex receptacle or bushed opening(s) for telephone and/or other communications service as indicated. Equip fitting for attaching flat to floor box cover.

J. Manufacturers: Subject to compliance with requirements, provide interior outlet boxes of one of the following:

1. Steel City/Thomas & Betts Company
2. Raco
3. Appleton
4. OZ/Gedney
5. Crouse Hinds

2.3 PULL AND JUNCTION BOXES

A. General: Comply with UL 50, "Electrical Cabinets and Boxes", for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.

B. Provide galvanized code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

C. Manufacturers: Subject to compliance with requirements, provide junction and pull boxes of one of the following:
   1. B-Line
   2. Hoffman Engineering Company
   3. Wiegmann/ a Hubbell Company

2.4 STEEL ENCLOSURES WITH HINGED DOORS

A. Comply with UL 50, "Cabinets and Enclosures" and NEMA 250.

B. ICS 6, "Enclosures for Industrial Controls and Systems."

C. Construction: Sheet steel, 14 gage, minimum, with continuous welded seams. NEMA class as indicated; arranged for surface mounting.

D. Doors: Hinged directly to cabinet and removable, with approximately 3/4-inch flange around all edges, shaped to cover edge of box. Provide handle operated, key locking latch. All locks associated with the same system shall be keyed alike. Individual door width shall be no greater than 24-inches. Provide multiple doors where required. Telephone cabinets wider than 48 inches may have sliding or removable doors.

E. Mounting Panel: Provide painted removable internal mounting panel for component installation.

F. Manufacturers: Subject to compliance with requirements, provide enclosures with hinged covers of one of the following:
   1. B-Line
   2. Hoffman Engineering Company
   3. Wiegmann/ a Hubbell Company
2.5 BUSHINGS, KNOCKOUT CLOSURES, AND LOCKNUTS

A. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes to suit respective installation requirements and applications.

B. Manufacturers: Subject to compliance with requirements, provide bushings, knockout closures, locknuts and connectors of one of the following:

   1. Steel City/T & B
   2. OZ/Gedney
   3. Appleton
   4. Crouse Hinds

2.6 MATERIALS AND FINISHES

A. Sheet Steel: Flat-rolled, code-gage, galvanized steel.

B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc-plated items.

C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.

D. Cast Metal for Boxes, Enclosures, and Covers: Copper-free aluminum, except as otherwise specified.

E. Exterior Finish: Gray baked enamel for items exposed in finished locations, except as otherwise indicated.

F. Painted Interior Finish: Where indicated, white baked enamel.

G. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Malleable iron or zinc-plated steel for conduit hubs, bushings, and box connectors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation" and in accordance with recognized industry practices to fulfill project requirements.

B. Locations:

   1. Electrical box locations shown on Contract Drawings are approximate unless dimensioned.
   2. Install items where indicated and where required to suit code requirements and installation conditions.
3. Locate and install boxes to allow access. Where installation is otherwise inaccessible, coordinate locations and sizes and provide required access doors.
4. Locate and install to maintain headroom and to present a neat appearance.
5. Avoid installing aluminum products in concrete.
6. Position recessed outlet boxes accurately to allow for surface finish thickness.
7. Set floor boxes level and flush with finish flooring material.
8. Avoid using round boxes where conduit must enter box through side of box, that would result in difficult and insecure connections when fastened with locknut or busing on rounded surfaces.
10. Subsequent to installation of boxes, protect boxes from construction debris and damage.
11. Do not install boxes back-to-back in walls. Provide minimum 6 inch (150 mm) separation.
   a. Exception: Provide minimum 24 inch (600 mm) separation in acoustic-rated walls.
12. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
13. Coordinate mounting heights and locations of wall outlets mounted where counters, benches, and backsplashes are to be installed. Install outlets 6" above tops of counters, benches, and backsplashes.
14. Coordinate mounting heights and locations of wall outlets where wall mounted heating units are to be installed. Install outlets in toe space below heating units.
15. Position outlets to locate luminaries as shown on reflected ceiling plans.
16. In inaccessible ceiling area, position outlets and junction boxes within 6 inches (150 mm) of recessed luminaire, to be accessible through luminaire ceiling opening.

C. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.

D. Support and fasten items securely in accordance with Division 260529.

E. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.

F. Remove sharp edges where they may come in contact with wiring or personnel.

3.2 APPLICATIONS

A. Cabinets: Flush mounted, NEMA enclosure type 1 except as otherwise indicated.

B. Hinged Door Enclosures: NEMA type 12 enclosure except as indicated.

C. Hinged Door Enclosures Outdoors: Install drip hood, factory tailored to individual units.

D. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:
   1. Interior Dry Locations: Sheet steel, NEMA type 1.
   2. Locations Exposed to Weather or Dampness: Cast metal, NEMA type 3R.
3.  Wet Locations:  NEMA type 4 enclosures.

E.  Pull and Junction Boxes:  Install pull and junction boxes of materials and NEMA types suitable for each location except as otherwise indicated.

F.  Floor Boxes:  In slabs on grade and wet locations use NEMA type 4 boxes.  At other locations in slabs, use concrete-tight NEMA 1 boxes.

3.3  INSTALLATION OF OUTLET BOXES

A.  Outlets at Windows and Doors:  Locate close to window trim.  For outlets indicated above doors use 7'- 9" mounting height above finished floor and center outlets above the door opening except as otherwise indicated.

B.  Column and Pilaster Locations:  Locate outlet boxes for switches and receptacles on columns or pilasters so the centers of the columns are clear for future installation of partitions.

C.  Locations in Special Finish Materials:  For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block, brick, stone or wood walls, use rectangular shaped boxes with square corners and straight sides.  Install such boxes without plaster rings.  Saw cut all recesses for outlet boxes in exposed masonry walls.

D.  Gasketed Boxes:  At the following locations use cast metal, threaded hub type boxes with gasketed weatherproof covers:
   1.  Exterior locations.
   2.  Where surface mounted on unfinished walls, columns or pilasters.  (Cover gaskets may be omitted in dry locations).
   3.  Where exposed to moisture laden atmosphere.
   4.  At food preparation equipment within four feet of steam connections.
   5.  Where indicated.

E.  Mounting:  Mount outlet boxes for switches with the long axis vertical or as indicated.  Mount boxes for receptacles either vertically or horizontally, but consistently either way.  Three or more gang boxes shall be mounted with the long axis horizontal.  Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally.  Locate boxes for switches near doors on the side opposite the hinges and close to door trim, even though electrical floor plans may show them on hinge side.

F.  Ceiling Outlets:  For fixtures, where wiring is concealed, use outlet boxes 4-inches square by 1-1/2-inches deep, minimum.

G.  Cover Plates for Surface Boxes:  Use plates sized to box front without overlap.

H.  Protect outlet boxes to prevent entrance of plaster and debris.  Thoroughly clean foreign material from boxes before conductors are installed.

I.  Concrete Boxes:  Use extra deep boxes to permit side conduit entrance without interfering with reinforcing, but do not use such boxes with over 6-inch depth.
J. **Floor Boxes:** Install in concrete floor slabs so they are completely enveloped in concrete except for the top. Where normal slab thickness will not envelop box as specified above, provide increased thickness of the slab. Provide each compartment of each floor box with grounding terminal consisting of a washer-in-head machine screw, not smaller than no. 10-32, screwed into a tapped hole in the box. Adjust covers of floor boxes flush with finished floor.

K. **Existing Outlet Boxes:** Where extension rings are required to be installed, drill new mounting holes in the rings to align with the mounting holes on the existing boxes where existing holes are not aligned.

### 3.4 INSTALLATION OF PULL AND JUNCTION BOXES

**A. Box Selection:** For boxes in main feeder conduit runs, use sizes not smaller than 8-inches square by 4-inches deep. Do not exceed 6 entering and 6 leaving raceways in a single box. Quantities of conductors (including equipment grounding conductors) in pull or junction box shall not exceed the following:

<table>
<thead>
<tr>
<th>Size of Largest Conductors in Box</th>
<th>Maximum no. of Conductors in Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4/0 AWG</td>
<td>30</td>
</tr>
<tr>
<td>250 kcmil</td>
<td>20</td>
</tr>
<tr>
<td>500 kcmil</td>
<td>15</td>
</tr>
<tr>
<td>Over 500 kcmil</td>
<td>10</td>
</tr>
</tbody>
</table>

**B. Cable Supports:** Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30-inches inside boxes.

**C. Size:** Provide pull and junction boxes for telephone, signal, and other systems at least 50 percent larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

### 3.5 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES

**A.** Mount with fronts straight and plumb.

**B.** Install with tops 78-inches above floor.

**C.** Set cabinets in finished spaces flush with walls.

### 3.6 GROUNDING

**A.** Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the cabinet, box or enclosure.
3.7 CLEANING AND FINISH REPAIR

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.

B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the manufacturer.

C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating recommended by the manufacturer.

END OF SECTION 26 0534
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. This section is part of each Division 23 and 26 section making reference to electrical connections for equipment specified herein.

C. Requirements of the following Division 26 sections apply to this section:
   1. 26 0500: Common Work Results for Electrical
   2. 26 0529: Hanger and Supports for Electrical Systems
   3. 26 0533: Raceway and Boxes for Electrical Systems
   4. 26 0534: Cabinets, Boxes, and Fittings
   5. 26 0553: Identification for Electrical Systems
   6. 26 2726: Wiring Devices
   7. 26 2816: Enclosed Switches and Circuit Breakers

1.2 EXAMINATION OF DOCUMENTS

A. Prior to the submitting of bids, the Contractor shall familiarize himself with all conditions affecting the proposed installation of equipment by all trades that will require electrical connections and shall make provisions as to the cost thereof. Failure to comply with the intent of this paragraph shall in no way relieve the Contractor of performing all necessary work required for final electrical connections and equipment.

1.3 SUMMARY

A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment. The Contractor shall provide connections to all electrically operated equipment furnished under other Sections and/or Divisions of this project Specification.

B. Applications of electrical power connections specified in this section include the following:
   1. To kitchen equipment.
   2. To shop equipment.
   3. From electrical source to motor starters.
   4. From motor starters to motors.
   5. To lighting fixtures.
   6. To transformers.
   7. To grounds including earthing connections.
   8. To master units of communication, signal, alarm, clock, public address, sound, and video systems.
C. Refer to Division 23 sections for control system wiring.

D. Refer to sections of other Divisions for specific individual equipment power requirements.

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 2 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.

C. NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches.


E. ANSI Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

F. UL Compliance: Comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials that are UL-listed and labeled.

G. ETL Compliance: Provide electrical connection products and materials that are ETL-listed and labeled.


I. FS W-C-596: Electrical power connector, plug, receptacle, and cable outlet.

J. NEMA WD 1: General purpose wiring devices.

K. NEMA WD 5: Specific purpose wiring devices.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's data on electrical connections for equipment products.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver electrical connection products wrapped in proper factory-fabricated type containers.
B. Store electrical connection products in original cartons and protect from weather, construction traffic, and debris.

C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

A. Straight-blade Attachment Plug: NEMA WD 1

B. Locking-blade Attachment Plug: NEMA WD 5

C. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.

D. Cord Construction: Oil-resistant thermoset insulated type

E. SO Multiconductor flexible cord with identified equipment ground conductor, suitable for (extra) hard usage in damp locations.

F. Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

G. Manufacturers: Subject to compliance with requirements, provide Cord and Caps of one of the following:

1. Hubbell
2. Cooper Wiring Devices
3. Pass and Seymour

2.2 MOTOR SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide motor switches of one of the following:

1. Cutler-Hammer
2. Square D
3. General Electric
4. Siemens

2.3 LOCAL DISCONNECTS

A. Manufacturers: Subject to compliance with requirements, provide heavy duty disconnect switches of one of the following:

1. Cutler-Hammer
2. Square D
3. General Electric
4. Siemens

PART 3 - EXECUTION

3.1 INSPECTION
A. Inspect areas and conditions under which electrical connections for equipment that will be installed and notify the Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Contractor. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 PREPARATION
A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.3 CABLES, CONDUITS, AND CONNECTIONS
A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

B. Metal Conduit, Tubing, and Fittings:
   1. General: Provide metal conduit, tubing, and fittings of types, grades, sizes, and weights (wall thickness) indicated for each type service. Provide products complying with Division 26 section “RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS”.

C. Wires, Cables, and Connectors:
   1. General: Unless noted otherwise, provide wires, cables, and connectors complying with Division 26 section “LOW-VOLTAGE ELECTRICAL POWER CABLES.
   2. Connectors and Terminals: Provide electrical connectors and terminals that mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.
   3. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wire-nuts and cable ties as recommended for use by accessories manufacturers for type services indicated.
3.4 POWER WIRING

A. Three Phase Circuits:
   1. As indicated on the drawings and required to provide complete power circuits to electrical equipment, this Contractor shall provide power conduit and wiring from the distribution panel to the equipment. This includes connections to all in line control, protection, and disconnection devices to provide a complete circuit to the equipment.
   2. This Contractor shall install all in line power control, protection, and disconnection devices furnished by others that are not an integral part of the equipment. These devices shall be located in accordance with the Contractor furnishing the devices and the requirements of the NEC.

B. Single Phase Circuits:
   1. For single-phase equipment provided under HVAC and Plumbing Contracts, the Electrical Contractor shall provide single-phase feeders and make final connection. This includes connections to all in line control, protection and disconnection devices to provide a complete circuit to the equipment.
   2. This Contractor shall install all in line power control, protection and disconnection devices furnished by others that are not an integral part of the equipment. These devices shall be located in accordance with the Contractor furnishing the devices and the requirements of the NEC.

3.5 CONTROL WIRING

A. Unless otherwise shown on the electrical drawings, all control wiring in Division 15 is the responsibility of the Contractor who provides the particular equipment. Control wiring includes the providing of all required motor controls, relays, pushbuttons, limit switches, pilot devices, all related raceway systems, conductors that provide control signals and final connections.

B. All other control wiring required by other Divisions of the Specifications shall be provided by this Contractor. Unless specifically indicated on the drawings or specified hereinafter to the contrary, all control devices such as starters, pushbuttons, limit switches, etc., are furnished under other Divisions of the Specifications. This Contractor shall receive these items and install same where shown on drawings. This Contractor shall provide all associated raceway, wiring, etc., in order to provide a complete and operational installation.

3.6 EQUIPMENT CONNECTIONS

A. This Contractor shall make final connections to all electrical equipment.

3.7 MOTOR SWITCHES

1. Except where furnished by another Contractor, this Contractor shall provide a surface-mounted toggle type, manual motor starter having an interchangeable thermal overload protective element, Square d Class 2510, for each single phase motor.
   a. Exception: Switches for motor loads under 1/6 HP shall be FS W-S-896; AC general use quiet operating switch with toggle handle, rated 20 amperes and 120-277 volts AC; handle - Ivory plastic.

B. Where motor switches are located remote or out of sight from equipment controlled, switch shall be provided with an approved neon pilot light.

C. Manual motor starters with low voltage protection.
   1. This Contractor shall provide a toggle type; manual motor starter having low voltage protection, surface mounted in a NEMA 1 enclosure, Square D Class 2510 where indicated on the drawings.

3.8 LOCAL DISCONNECTS
A. Where the motor is located out of sight or more than 50 feet from its circuit breaker (or combination starter) this Contractor shall provide a properly rated motor circuit switch at the motor location in accordance with the CIRCUIT AND MOTOR DISCONNECT section of this Specification.

Exceptions:
   1. Where equipment is furnished complete with an approved integral disconnect.
   2. Cord cap and matching receptacle will be acceptable as disconnect for cord connected welders and cord connected food service equipment. Cord cap and receptacle will also be acceptable for cord connected 120 volt equipment of not more than 1/4 HP or 10 amperes nameplate current.

B. Comply with all manufacturers’ printed instructions, wiring diagrams and approved submittal data.

C. Provide all required flexible connections, cords, caps and receptacles as required and approved.

3.9 KITCHEN EQUIPMENT
A. Connections shall be as shown on Electrical Drawings and Food Service Consultant's drawings.

3.10 TECHNOLOGY SHOP EQUIPMENT
A. Connections shall be as shown on Electrical Drawings and Architect's Equipment Drawings.

3.11 ELEVATORS
A. Connections for and coordination of elevators shall include, but not be limited to the following:
1. Disconnect switch and feeder extended to and connected at equipment controller.
2. Dedicated power outlets and circuitry for car lights and fans. All such outlets are to be served by the emergency generator.
3. Empty conduit for telephone communications.
4. Lighting outlet, switch and duplex outlet within each elevator pit.
5. Conduit and wire from fire alarm panel to elevator controller.

3.12 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL's 486A.

E. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.

F. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.

G. Make conduit connections to equipment using flexible conduit 24” maximum. Use liquidtight flexible conduit in damp or wet locations.

H. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.

I. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.

J. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
K. Fasten identification markers to each electrical power supply wire/cable conductor that indicates their voltage, phase and feeder number in accordance with Division 260553. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.13 EQUIPMENT ROTATION

A. This Contractor shall be responsible for proper rotation of all three phase motors.

3.14 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION 26 0535
SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   B. This section is a part of each Division 26 section making reference to identification specified herein.
   C. Requirements of the following Division 26 Sections apply to this section:
      1. 26 0100: Basic Electrical Requirements
      2. 26 0500: Common Work Results for Electrical

1.2 SUMMARY
   A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:
      1. Buried electrical line warnings.
      2. Identification labeling for raceways, cables, and conductors.
      3. Operational instruction signs.
      4. Warning and caution signs.
      5. Equipment labels and signs.
   B. Refer to Division-01 General Requirements Section, "Identification Systems" for equipment and system nameplates and performance data; not work of this section.
   C. Refer to other Division 26 sections for additional specific electrical identification associated with specific items.

1.3 SUBMITTALS
   A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
   B. Product Data: Manufacturer's data for each type of product specified.
   C. Schedule of identification nomenclature to be used for identification signs and labels.
   D. Samples of each color, lettering style, and other graphic representation required for identification materials; samples of labels and signs.
1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical identification products of types required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical identification work similar to that required for this project.

C. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

D. UL Compliance: Comply with applicable requirements of UL Standard 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

E. ANSI Compliance: Comply with applicable requirements of ANSI Standard A13.1 "Scheme for the Identification of Piping Systems", with regard to type and size of lettering for raceway and cable labels. Comply with the requirements of ANSI Standard C2.

F. NEMA Compliance: Comply with applicable requirements of NEMA Standard No's. WC-1 and WC-2 pertaining to identification of power and control conductors.

G. NFPA Compliance: Comply with applicable requirements of NFPA Standard 70 pertaining to color coding, signage, and identification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following (for each type marker):

1. Alarm Supply Company, Inc.
2. Bunting Graphics
3. Brady, W.H. Company
4. Calpico Inc.
5. Cole-Flex Corporation
6. Direct Safety Company
7. George-Ingraham Corporation
8. Griffolyn Company
9. Ideal Industries, Inc.
10. LEM Products, Inc.
11. Markal Company
12. National Band and Tag Company
13. Panduit Corporation
14. Radar Engineers Div.; EPIC Corporation
15. Seton Name Plate Company
16. Tesa Corporation
2.2 ELECTRICAL IDENTIFICATION PRODUCTS

A. Adhesive Marking Labels for Raceway and Metal-clad Cable: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service (Emergency, Lighting, Power, Communications, Control, Fire, Low Voltage, etc.).

1. Label Size: as follows:
   
   b. Raceways Larger than 1-Inch: 1-1/8 inches high by 8 inches long.
   c. Cable Trays: 2 inches high, length as required for lettering per "Cable Tray" section of this Specification.

B. Cable/Conductor Identification Bands:

1. General: Provide manufacturer's standard aluminum wrap-around cable/conductor markers, of size required for proper application with stamped or embossed legend, and numbered to show circuit identification.

C. Operational Instruction Signs:

1. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention and operation tags, of plasticized card stock with matte finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

D. Warning and Caution Signs:

1. General: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20-gage steel; of standard red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size that can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.

E. Equipment Labels:

1. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thickness indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening.
   
   2. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.

F. Lettering and Graphics:

1. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.
G. Fasteners for Plastic-Laminated and Metal Signs:
   1. General: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
      a. Exception: Where specifically approved contact type permanent adhesive may be used in areas where screws cannot or should not penetrate substrate.

   1. Not less than 6 inches wide by 4 mils thick (152mm wide by 0.102mm thick).
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend indicating type of underground line.

PART 3 - EXECUTION

3.1 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

B. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.

C. Install identification devices as indicated, in accordance with manufacturer's written instructions and requirements of NEC.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Regulations: Comply with governing regulations and requests of governing authorities for the identification of electrical work.

3.2 CABLE/CONDUCTOR IDENTIFICATION

A. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

B. Color-Coding of Secondary Phase Conductors: Use the following colors for service feeder and branch-circuit phase conductors:
1. 208/120V Conductors:
   a. Phase A: Black
   b. Phase B: Red
   c. Phase C: Blue

2. 480/277V Conductors:
   a. Phase A: Yellow
   b. Phase B: Brown
   c. Phase C: Orange

3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
   a. Colored, pressure sensitive plastic tape in half-lapped turns for a distance of 6 inches (150mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch – (25-mm) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
   b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

C. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Limit use of line markers to direct-burial cables. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

3.3 OPERATION, WARNING, AND CAUTION SIGNS

A. Provide operational, warning, and caution signs wherever required by NEC, where indicated or where reasonably required to assure safety and efficient operation and maintenance of electrical systems and of the items to which they connect, including the prevention of misuse of electrical facilities by unauthorized personnel.

B. Provide instruction signs with approved legend where instructions or explanations are needed for system or equipment operation.

C. Provide instruction and/or warning signs on switches, outlets and other controls, devices and electrical enclosures as directed.
3.4  DANGER SIGNS

A. General: In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer or electrical work as constituting similar dangers for persons in or about project.

B. High Voltage: Install danger signs wherever is possible, under any circumstances, where persons may come into contact with electrical power of voltages higher than 110-120 volts.

C. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

3.5  EMERGENCY OPERATING SIGNS

A. Provide engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

3.6  INSTALLATION

A. Provide equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 1/2-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), white lettering in black field. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.

1. Panelboards, electrical cabinets, and enclosures.
2. Access doors and panels for concealed electrical items.
4. Disconnect switches.
5. Pushbutton stations.
6. Intercom system components.
7. Electrical switchboards.
8. Emergency system boxes and enclosures.
10. Power transfer equipment.
11. Contactors.
15. Transformers.
16. Power-generating units.
17. Telephone switching equipment.
18. Clock/program master equipment.
19. Call system master station.
20. TV/audio-monitoring master station.
21. Fire alarm master station or control panel.
22. Security-monitoring master station or control panel.

B. Provide labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment. In finished areas install panelboard labels to inside face of all recessed panelboard doors.

END OF SECTION 26 0553
SECTION 26 0573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   B. This section is a Division 16 BASIC ELECTRICAL MATERIALS AND METHODS, and is a part of each Division 16 section.

1.2 SUMMARY
   A. This Section includes provisions for electrical distribution coordination, short circuit analysis, and shock and flash hazard studies.

1.3 SUBMITTALS
   A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
      1. Eight bound copies or coordination, short circuit, and shock and flash hazard studies.
      2. Electronic copy of studies on CD (8 copies).
      3. All flash hazard labels for use on equipment associated with the study (3 copies).

1.4 QUALITY ASSURANCE
   A. Qualifications: Firm engaged in performing studies of this type for at least 5 years.

1.5 SEQUENCE AND SCHEDULING
   A. Contractor shall submit 3 copies of preliminary coordination and short circuit study prior to submitting distribution equipment submittals. No submittals for switchgear, switchboards, panelboards, transformers, etc., will be approved without prior submittal of coordination and short circuit study.
   B. If preliminary study indicates issues with equipment that will be submitted, preliminary study shall be rerun using alternate equipment with ratings and settings appropriate for the system being installed.
   C. After approval of preliminary coordination study, contractor shall submit distribution equipment submittals for approval, including any necessary revisions indicated by preliminary coordination and short circuit study.
D. Provide final bound coordination, short circuit, and shock and flash hazard study. Provide PPE labels for all equipment being provided, and for existing equipment included in study. Provide CD with each copy of study containing all study files and input files.

PART 2 - PRODUCTS

2.1 STUDIES

A. Provide, in accordance with industry standards, the electrical studies listed in this section.

B. All studies shall incorporate the actual equipment being provided, and actual cable lengths, conduit types, and wire sizes of feeders being installed. Provide all field survey work necessary to obtain all required information from existing equipment that will be connected to as part of this project, in order to include existing equipment in study. This includes, but is not limited to, nameplate information, catalog numbers, trip unit settings, and relay settings.

C. All studies shall be performed using analysis software as manufactured by SKM Systems Analysis, Inc.

2.2 ELECTRICAL DISTRIBUTION COORDINATION STUDY

A. Provide a complete electrical distribution coordination study, based on the equipment being submitted. Submit complete documentation of the coordination of all circuit breakers and fused switches. The study shall provide recommendations for the settings of all adjustable devices (i.e. ground fault, adjustable breakers) to provide maximum coordination and selectivity. This report shall include a composite drawing for each segment of the distribution system showing the time-current curves of all devices, with the devices set as recommended. This shall include the complete characteristic curves for all circuit protection devices. Study shall include all 5kV equipment on project.

2.3 SHORT CIRCUIT ANALYSIS

A. Provide a complete short circuit analysis, based on the actual equipment and conductor lengths provided by the Contractor. Analysis shall include all new equipment on project, and any and all existing equipment to which new equipment or feeders are being connected to.

2.4 SHOCK HAZARD AND FLASH HAZARD ANALYSIS

A. Provide a complete shock hazard and flash hazard analysis, based on the actual equipment and conductor lengths provided by the Contractor. Provide for all warning signs and classification signage on all distribution equipment as required by NFPA 70E, 2009 Edition.
PART 3 - EXECUTION

3.1 GENERAL

A. Provide for adjustment and setting of all trip units and relays according to coordination study recommendations.

B. Install all PPE labels on equipment.

END OF SECTION 26 0573
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SECTION 26 0923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference lighting control devices specified herein.

C. Requirements of the following Division 26 Sections apply to this section:

1. 26 0933: Architectural Dimming Controls
2. 26 0943: Network Lighting Controls

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Wallbox dimmer switches
2. Outdoor / Indoor photoelectric switches.
3. Indoor occupancy sensors.
4. Outdoor motion sensors.
5. Digital time switch.
7. Emergency shunt relays.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Wiring Diagrams: Submit wiring diagrams showing connections to branch circuit wiring, switches, and controls. Differentiate between portions of electrical wiring that are manufacturer-installed and portions that are field installed.

C. The Contractor shall verify color selections with the Architect and Owner prior to ordering any devices. Where a specific color is not specified and options exist, submit color and/or finish samples for selection by Architect.

D. Shop Drawings: Submit shop drawings in booklet form with separate sheet for each lighting control devices with catalog numbers clearly indicated on each sheet.
E. Samples: Manufacturers shall be prepared to submit complete samples for approval by Architect and Engineer. Samples shall be submitted only at the request of the Architect/Engineer. Samples shall be shipped prepaid by the Contractor and shall be furnished within two weeks of the request. Samples shall be evaluated for two weeks prior to acceptance or rejection. Samples shall remain on the project site as an example of materials, workmanship, finish, color, tolerance, performance, and general quality of all other sensors of the respective type to be installed on the project. The Architect/Engineer shall be the final judge of acceptance.

1.4 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.5 QUALITY ASSURANCE

A. It is the sole responsibility of the Electrical Contractor to ensure that the devices submitted meet or exceed the functional intent and design quality standards in this specification.

1.6 LISTING AND LABELING

A. The terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

B. Provide devices that are listed and labeled for their indicated use on the project.

C. Special Listing and Labeling: Provide devices for use in damp or wet locations, and recessed, specifically listed and labeled for such use.

D. Listing and Labeling Agency Qualification: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. All devices shall be U.L. listed specifically for the loads and voltages as shown on the drawings and as scheduled.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver control devices and accessories in factory-fabricated containers or wrappings that properly protect devices from debris and physical damage.

B. Handle devices carefully to prevent damage, breaking, and scoring. Do not install damaged devices or components; replace with new.

C. Store devices in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
1.8 SEQUENCING AND SCHEDULING

A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface with installation of lighting control devices.

B. Schedule work with other Contractors to properly interface with installation of other equipment, especially ceilings, access doors, partitions, etc.

C. Sequence control device installation with other work to reduce the possibility of damage and soiling of devices during remainder of construction period.

1.9 WARRANTY

A. All occupancy sensors, ambient light sensors, and photocells shall be warranted for a minimum of 5 years. Dimmers, timeswitches, and lighting contactors shall be warranted for a minimum of 1 year. If a device fails within this period, the manufacturer shall replace the unit.

1.10 MAINTENANCE

A. Maintenance Data: Submit maintenance data and parts lists for each lighting control device, tools required, cleaning methods and materials, and including "trouble-shooting" maintenance guide. Include the product data, and shop drawings in the maintenance manual; in accordance with requirements of Division 1.

B. Furnish extra materials matching products installed, as described below, packaged with protective covering for storage, and identified with labels describing contents. Deliver extra materials to the Owner.

C. Extra Stock: Deliver replacement stock as directed to Owner's storage space, and obtain receipt.

   1. Occupancy Sensors: 1 sensor for each 100 of each type and rating installed. Furnish at least 1 of each type.
   2. Sensor Power Packs: 1 for each 100 of each type and rating installed. Furnish at least 1 for each type.
   3. Photocells: Furnish at least 1 of each type and rating installed.

PART 2 - PRODUCTS

2.1 WALL BOX DIMMER SWITCHES

A. Manufacturers: Subject to compliance with the dimmer manufacturer's requirements and recommendations, provide products from the following:

   1. Lutron - Nova T Series
   2. Hubbell - AS Series
   3. Lightolier - Sunrise Series
B. General:

1. Dimmers shall operate in an ambient temperature range of 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F).
2. All dimmers shall be linear slide preset dimmers with power-failure memory. Dimmers shall incorporate separate control of intensity and on/off.
4. Dimmers shall include voltage compensation circuitry that adjusts the firing angle of the dimmer in such a manner as to compensate light output for variations in the AC line voltage. Dimmers in which the firing angle is merely held constant with varying AC line voltage shall not be acceptable.
5. All dimmers shall provide smooth and continuous IES Square Law Dimming Curve throughout the entire dimming range. Lamp flicker shall not be acceptable.
6. Dimmers shall incorporate a filter network to minimize interference (RFI) with radio, audio, and video equipment.
7. Dimmers shall incorporate an air-gap switch to meet the requirements of U.L. 20 for air-gap switches in incandescent dimmers.
8. All dimmers shall be NEMA WD-2 listed for Semiconductor dimmers for incandescent lamps."

2.2 OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with the sensor manufacturer's requirements and recommendations, provide products from the following:

1. Wattstopper
2. Sensor Switch
3. Philips Controls
4. Cooper Controls

B. General:

1. All occupancy sensors shall have adjustable time delays from 30 seconds to 15 minutes and adjustable sensitivity.
2. All sensors shall have an LED to indicate occupant detection.
3. All sensors shall operate with all lamp and ballast combinations, including magnetic, hybrid, and solid-state ballasts.

C. PIR/Ultrasonic occupancy sensors:

1. Ceiling ultrasonic occupancy sensors shall have 360 degree coverage with a ceiling height of 12 feet.
2. The ultrasonic circuit shall be solid state, crystal controlled, with solid state transducers. The sensor shall operate at a minimum of 30 KHz.
3. Ceiling ultrasonic sensors shall be low voltage wired in parallel to a common power pack as recommended by the manufacturer. The sensor shall incorporate to a convenient bypass switch that will enable the lighting to be turned on if a sensor fails.
4. Ceiling passive infrared sensors shall be low voltage wired in parallel to a common power pack as recommended by the manufacturer.
5. Ceiling passive infrared occupancy sensors shall have round, square, or long rectangular coverage patterns to match the floor plan layout as recommended by the sensor manufacturer. The passive infrared sensor shall operate within a ceiling height of 12 feet.

6. The passive infrared sensor shall incorporate a temperature compensated dual element sensor and a multi element fresnel lens. The sensor shall have a daylight filter to ensure the sensor is insensitive to short-wavelengths emitted by the sun.

D. Dual Technology Occupancy Sensors:

1. Dual technology occupancy sensors shall include both ultrasonic and passive infrared sensors ONLY.
2. Each sensing technology shall have independent sensitivity adjustments and LED to indicate detection.
3. Dual technology sensors shall be designed to be either wall or ceiling mounted as indicated on drawings.
4. The sensor must sense motion from both technologies to turn lighting on, but maintained detection from either technology will hold lighting on for the set time delay.
5. Dual technology sensors shall be low voltage wired to sensor power packs as recommended by the manufacturer. The sensor shall contain an isolated relay with normally open, normally closed, and common outputs for use with building automation systems, mechanical controls, data logging, or other system control options.

E. Sensor Power Packs:

1. Sensor power packs shall be self-contained transformer relay modules.
2. Power packs shall have dry contacts capable of switching a 20 amp load at either 120VAC or 227VAC.
3. The power packs shall provide 24VDC output capable of controlling ultrasonic or passive infrared occupancy sensors as recommended by the sensor manufacturer.

F. Wall Box Occupancy Sensors:

1. Wall passive infrared occupancy sensors shall have a minimum 170 degree radial spread pattern with a minimum of 20 feet axial sensor coverage.
2. Passive infrared sensors shall incorporate temperature compensated dual element sensor and multi element fresnel lens. The sensor shall have a daylight filter to ensure the sensor is insensitive to short-wavelengths emitted by the sun.
3. Wall passive infrared occupancy sensors shall be completely self contained to replace standard toggle switches. Power supply shall be an internal transformer. Switching mechanism shall be a latching air gap relay.
4. Alternately, wall passive infrared occupancy sensors may be low voltage devices with sensor power packs similar to the ceiling mounted devices specified herein.
5. Wall passive infrared sensors shall have a switch for either off or auto for normal operation. The sensor shall incorporate a convenient by-pass switch that will enable the lighting to be turned on if a sensor fails.
6. Wall passive infrared switched occupancy sensors shall incorporate all the feature sand performance of the passive infrared sensors except for switching.
7. Wall passive infrared switched occupancy sensors shall be user adjustable for normal operation. The sensor shall operate similar to a toggle switch, tap on and tap off, with the sensor maintaining lighting during detection and time delay lights off. Alternate
operation shall be same as other sensors specified, sensor detection lights on, with sensor maintaining lighting during detection and time delay off.

8. Wall passive infrared occupancy sensors with ambient light sensor shall incorporate all of the features and performance of the passive infrared sensors and ambient light sensors. The ambient light sensor shall be internal with a range of approximately 5 to 300 footcandles. The ambient light sensing component shall not permit lighting systems to be turned on if enough daylight is present.

2.3 PHOTO CELLS

A. Manufacturers: Subject to compliance with the sensor manufacturer's requirements and recommendations, provide products from the following:

1. Sensor Switch
2. Wattstopper
3. Cooper Controls
4. Hubbell Building Automation

B. The controller shall be rated 2000 watts tungsten at 120, 240 or 277 volts. The cell shall be cadmium sulfide, 1" diameter. The enclosure shall be die cast zinc, gasketed for maximum weather proofing.

C. The enclosure shall include the positioning lug on the top of the enclosure.

D. The unit shall have a deadband of up to two minutes to prevent cycling lighting. ON/OFF adjustment shall be done by moving a light selector with a range from 2 to 50 footcandles.

E. Mounting shall be for a 1/2" conduit nipple.

F. The contact shall be SPST normally closed.

G. The operational temperature range shall be -40 to 140 degrees F(-40 to +60 degrees C).

2.4 DIGITAL TIME SWITCHES

A. Manufacturers: Subject to compliance with the manufacturer's requirements and recommendations, provide products from the following:

1. Wattstopper
2. Philips Controls
3. Cooper Controls
4. Sensor Switch

B. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status
2. Control: On-off operation
2.5 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lighting Control and Design, Inc.
2. Bodine

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120v or 277v

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect each installed device for damage. Replace damaged devices and components.

B. Give advance notice of dates and times for field tests.

C. Tests: Verify normal operation of each device after devices have been installed and circuits energized with normal power source.

D. Replace or repair malfunctioning devices and components, then retest. Repeat procedure until all units operate properly.

3.2 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section, "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 ADJUSTING AND CLEANING

A. Clean devices upon completion of installation. Use methods and materials recommended by manufacturer. Devices with dust, dirt, scratches, or fingerprints shall not be acceptable.

B. The Contractor shall be responsible for final adjustment and testing of all devices.

C. Check dimmer preset control for proper operation.

D. Verify that dimmers function without producing lamp flicker or audible noise.

E. Verify that dimmers function without interference of audio and visual equipment.

F. Adjust all occupancy sensors to same time delay of five (5) minutes.

G. Verify proper operation of occupancy sensor switches and by-pass switches.

H. Sensitivity Test: After the occupancy sensor has been energized for at least 15 minutes, walk to the middle of the room (if conference room) or sit at the normal desk position (if office). Make no motion for 20 seconds. Move one arm up and down slowly. The test LED should blink.

I. Time Delay Test: Set the occupancy sensor time delay for 10 minutes. Walk into the room to activate the sensor then leave room. Sensor must turn lights off at approximately 10 minutes. Walk into the room again to reactivate the lights. Lights should activate within 1 second.

J. Adjust occupancy sensor sensitivity such that movement outside the range of coverage shall not false trigger the sensor.
3.7 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

3.8 GROUNDING

A. Provide equipment grounding connections for all lighting control devices.

END OF SECTION 26 0923
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SECTION 26 0933 - ARCHITECTURAL DIMMING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This section is a part of each Division 26 section making reference to dimming specified herein.

B. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0100: Basic Electrical Requirements
   2. 26 0500: Common Work Results for Electrical
   3. 26 5100: Interior Lighting

C. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes a complete architectural lighting dimming system as specified herein and on the drawings, details and schedules.

B. The system shall consist of factory pre-assembled dimming panels and low voltage control stations. The system shall be provided complete with all necessary accessories for a complete installation.

C. The entire system shall be U.L. listed and shall bear a U.L. label on each dimming panel. Each dimming module shall be U.L. listed for control of the specific type of load it controls.

1.3 DEFINITIONS

A. Fade Override: The ability to temporarily set fade times to zero for all lighting scenes.

B. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.

C. Fade Time: The time it takes all zones to fade from one lighting scene to another, with all zones arriving at the next scene at the same time.

D. Low Voltage: As defined in NFPA 70, term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.

E. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.

F. SCR: Silicon-controlled rectifier.

G. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."
1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Wiring Diagrams: Submit wiring diagrams for connections to branch circuit wiring, low voltage control stations, and accessories. Differentiate between portions of electrical wiring which are manufacturer-installed and portions which are field installed.

C. Product data describing complete system in the form of a booklet with a separate sheet for each component of the system with catalog numbers clearly indicated on each sheet. Include dimensional data on all features and accessories. Include the following information:
   1. Interconnection diagrams showing a detail of each control station, the scenes and zones that are on that control, and the interconnecting wiring between controls and dimmers.
   2. Complete dimmer load schedules, including room or area being controlled, dimmer capacity, load type, panelboard and circuit number, and scene and zone controls.
   3. Mechanical and electrical notes and construction details for dimming panels and controls.
   4. Device plates, plate color, and material
   5. For dimmer panels; include dimensions, features, dimmer characteristics, ratings, and directories.

D. Manufacturer shall provide all additional information or demonstrations required by Engineer to demonstrate conformance with the specifications herein. Demonstrations are to be at a time and location and in a manner chosen by the Engineer.

E. Where a specific color is not specified and options exist, submit color and/or finish samples for selection by Architect.

F. Operation and Maintenance Data: For central dimming controls with remote-mounting dimmers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Software manuals.
   2. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
   3. Operation of adjustable zone controls.
   4. Testing and adjusting of panic and emergency power features.

1.5 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of dimming systems of types and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Alternate manufacturers: As listed in this specification. The alternate manufacturers are presented as possible sources of the specified system. Approval of manufacturers considering there products equal will be subject to the following:
   1. Alternate manufacturers must nominally meet specifications of specified system considering the application in the environment and intended usage by the Owner.
2. It shall be understood that any and all additions or revisions of wiring required by the use of alternate manufacturers, whether such wiring is part of the system or the prime electrical contract, shall be the responsibility of the Electrical Contractor.

3. Any and all additions or revisions of wiring required by the use of alternate manufacturers, whether such wiring is part of the system or the prime electrical contract, shall be the responsibility of the Electrical Contractor.

C. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with dimming system work similar to that required for project.

D. Source Limitations: Obtain central dimming controls from a single source with total responsibility for compatibility of lighting control system components specified in this Section, in Division 26 Section "Network Lighting Controls," and in Division 26 Section "Lighting Control Devices."

1.6 LISTING AND LABELING

A. The terms "Listed" and Labeled": As defined in the National Electrical Code, Article 100.

B. System shall be U.L. listed specifically for the loads and voltages as shown on the drawings and as scheduled.

C. The complete system shall be listed with UL and CSA.

D. The complete system shall meet FCC Emission Standards.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

G. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver system and accessories in factory-fabricated containers or wrappings, that properly protect components from debris and physical damage.

B. Handle dimmers and stations carefully to prevent damage, breaking, and scoring. Do not install damaged components; replace with new.

C. Store system in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceways, to properly interface with installation of dimming system.
B. Schedule work with other Contractors to properly interface with installation of other equipment.

C. Sequence system installation with other work to reduce the possibility of damage and soiling during remainder of construction period.

1.9 WARRANTY
A. Manufacturers shall guarantee all components and systems to be free from defects in workmanship and materials for a period of one (1) year from the date of acceptance by the Owner. During the guarantee period, the manufacturer shall perform all services necessary on the system.

1.10 MAINTENANCE
A. Maintenance Data: Submit maintenance data and parts list for each preset dimming system component, tools required, cleaning methods and materials, and including "trouble-shooting" maintenance guide, service manuals, and a current list of local manufacturer approved service centers. Include the product data, and shop drawings in the maintenance manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers:

1. Subject to compliance with the preset dimming system manufacturer's requirements and recommendations, provide products from the following:

a. ETC
b. Lutron
c. Leviton
d. Lightolier Controls

2. It is the sole responsibility of the Contractor to ensure that dimming systems submitted meet or exceed the functional intent and design quality standards in this specification.

B. General:

1. Dimming Panels

a. Panels shall be wall or floor mounted NEMA 1 enclosures, constructed of not less than #14 gauge sheet steel plates.
b. Panels shall be pre-wired by the manufacturer. Contractor shall provide input feed wiring, load wiring and control wiring that terminates to clearly marked low voltage terminals. No additional wiring or assembly by the Contractor shall be necessary.
c. Panels shall contain output circuit breakers to provide outgoing branch circuit protection for each dimming module. Circuit breakers shall have same short circuit rating as overcurrent protective device feeding dimming cabinets.

d. Contractor shall verify the integrity of dimmed circuits using actual loads and test circuits that bypass the dimmer modules, prior to connection of the dimmer output terminal or branch circuit breaker. Dimming panels shall contain mechanical or electronic bypass function to assist in the maintenance of the system.

e. Panels shall provide the capability to electronically assign each circuit to any zone in the dimming system. Panels that require mechanical switching or rewiring shall not be acceptable.

f. Multiple panels shall be capable of operating in one dimming system and be capable of common control stations.

g. Panels shall be cooled exclusively by means of free convection, unaided by fans, in an ambient temperature range of 0°C (32°F) or 40°C (104°F). Alternatively, fans may be used with the following additional provisions:

1) Fans shall be quiet and not introduce objectionable noise into occupied space. Fans shall have a maximum NC rating of 43.
2) Fans shall operate when any dimmer module is above 5% and shall be shut off at all other times.
3) There shall be an overtemperature protection circuit to prevent dimmers from operating in an unacceptably hot environment. An overtemp indicator shall be illuminated on the face of each dimming panel.

2. Dimming Modules

a. Comply with UL 508.

b. Silicon thyristors or SSRs shall control the power furnished to the loads. These devices shall carry the full load. They shall be capable of withstanding surges, without impairment to performance, of 6000V and 3000A as specified by the current edition of ANSI/IEEE Std. C62.41. Under full load operating conditions in a 40 degree C ambient, devices shall operate at a minimum 20 degree C safety margin below the component temperature rating.

c. Dimming module main power semiconductors shall be 100% tested at rated voltage at a case temperature of 100 degrees C.

d. Dimming modules shall be voltage regulated so that ∀10% change in voltage shall cause less than +or- 3% change in output voltage.

e. Dimming modules shall provide a smooth and continuous IES Modified Square Law Dimming Curve throughout the entire dimming range.

f. Universal dimming modules that do not adjust the dimming curve shall not be acceptable.

g. Dimming modules that produce lamp "buzz" or "hum" shall not be acceptable.

h. Maximum and minimum light levels shall be adjustable for each module.

i. Incandescent and Low Voltage Loads:

1) Filtering shall be provided in each dimmer so that current rise time shall be at least 350msec at 50% rated dimmer capacity as measured from 10-90% of the load current waveform at a 90E conduction angle, and at no point rise faster than 30mA/msec.
2) Incandescent dimming modules shall contain toroidal filtering chokes to minimize harmonics, radiated radio frequencies, electromagnetic interference, and noise in the load lamp filament.

3) Low voltage dimming modules shall be capable of dimming magnetic or electronic loads as scheduled in the dimming load schedule and fixture schedule.

4) Modules shall provide a dimming range from 100% to 0% (blackout). Minimum light levels shall be user adjustable in order to compensate for different loading of each dimmer module.

5) Dimmer output voltage shall be a minimum of 95% of input voltage at maximum intensity setting.

j. Fluorescent Loads:

1) Refer to Section 265100 for dimmable electronic ballast specification.

2) Fluorescent dimming modules shall be rated to control 430 mA rapid start, 800 mA high output, or 265 mA compact fluorescent lamps as specified in the fixture schedule and in Section 265100. All lamps on the same circuit and the corresponding dimming module shall operate at the same frequency.

3) Fluorescent dimming modules shall perform as follows:

   a) Modules shall have a dimming range from 100% to 5% light output and 0% control input from a control station shall turn the dimmer off.

   b) Modules shall contain a relay to automatically remove power to the circuit feeding the dimming ballast when the control station is off.

   c) Different lamp lengths or one and two lamp ballasts on the same circuit shall track evenly with no perceptible difference in light levels for the same type of lamps.

   d) Minimum light levels shall be user adjustable to compensate for different loading of each dimmer module.

   e) Maximum allowable asymmetry in the load waveform shall be +/- 1 VDC.

   f) Modules shall be approved by the ballast manufacturer for the control of the ballasts provided. The dimming system manufacturer shall be responsible for the ballast/module compatibility.

   g) Module and ballast combination shall not operate fluorescent lamps outside the applicable ANSI standard.

   h) Dimmer shall incorporate circuitry to prevent the lights from momentarily "flashing" when the dimmer is turned ON or OFF.

k. Non-Dimmable Loads:

1) The non-dimmable module shall be rated to switch 16 Amps at 120 Volts of resistive, tungsten, inductive, or capacitive loads.

2) When used with a preset control system, the non-dimmable relay module shall turn on and off at the start of the light level transition period.

3) Alternately, the relay module on/off point shall be field programmable from 5% to 99% control input. An internal deadband or offset shall prevent cycling on/off. It shall be acceptable to program dimmer modules for non-dim operation.
Remote Power Booster:

1) Remote power boosters shall increase the master dimmer control capacity range from 2,000 watts to 30,000 watts as required. The remote power boosters shall be controlled via low voltage control wiring from the master dimming control station.

3. Controls:

a. Controls shall be low voltage type as specified herein and as listed below and/or shown on the drawings. Provide a separate set of terminals for each control station termination at the dimming panel and/or interface panels.

b. Control stations shall provide power-failure memory. If power to the control station is momentarily interrupted, lights will come back on at the same levels set prior to the power interruption. Restoration to a different default level is not acceptable.

c. Stations shall be as shown and specified herein. Station faceplate samples shall be submitted for approval by the Architect for labeling and appearance. All stations shall provide a ground path for static discharges from operator’s hands.

d. Faceplates shall attach to the wallbox using no visible means of attachment. To prevent unauthorized faceplate removal, set screws through the edge of the faceplate shall securely hold the faceplate to the switchbox.

e. Faceplate Color reference Section 262726 “Wiring Devices” - Submit Samples

f. Control faceplates shall be labeled with appropriate zone and/or scene descriptions shown on the dimming load schedule. Labeling shall be approved by the Owner prior to release for manufacture of faceplates. Size and style of labeling type shall be determined by the Architect. Graphics shall be chemically bonded to the faceplate, resisting removal by scratching, cleaning, etc. Alternately, the zone and/or scene shall be identified on the control station LCD display.

g. Control stations shall be flush mounted and shall have LCD or LED display of the active scenes and zones.

h. Preset Dimming Control Station:

1) Preset dimming control stations shall contain a momentary contact switch with integral LED pilot light indicating on/off status. There shall be one manual slide or potentiometer for each specified zone of control. There shall be a master manual slide control for proportional override of all zones together within the same scene. Each manual slide shall be silk-screened to indicate 10% increments of light output. Operation of the momentary contact switch shall activate control of the dimming system at that control location and turn the system on. The preset dimming control station shall contain one additional momentary contact switch for each scene of control specified. Fade rate between scenes for all zones shall be adjustable from 0 to 60 seconds or 1 to 59 minutes. There shall be no limit on the number of stations that can be used to control the system.

i. Scene Selection Control Station:

1) Scene selection control stations shall consist of a momentary contact touch button, with adjacent LED indicator light, for each scene to provide scene
selection. There shall be electronic fade between scenes. An additional touch button shall switch the system all on or off.

j. Entrance Control Station:

1) The entrance control station shall include one touch button and shall be capable of recalling scene "one" and switching the system off.

k. A/V Interface Control:

1) The audio/visual controller shall be capable of accepting 5 inputs and 5 outputs for integrating building systems, such as A/V equipment, building automation systems, security systems, timeclocks, and occupancy sensors. The controller shall accept momentary or maintained, dry or wet contacts from the building systems. Dip switches on the controller shall set the program for inputs and outputs. Alternately, the controller shall be provided with an RS232 interface for communication to and from the audio visual equipment.

2) The audio/visual controller shall install on a standard junction box above an accessible ceiling.

l. Remote Control:

1) Wireless remote control shall consist of a hand-held battery operated infrared or radio frequency transmitters and a ceiling or wall mounted receivers.

2) The hand-held transmitter shall contain the same scene activating touch buttons with LED's and one off touch button as specified in the scene selection control stations. The transmitter shall not produce any radio frequency interference with audio/visual equipment. The range of the transmitter to any receiver shall be at least 60 feet. Receivers may be connected in parallel to increase the effective range.

3) Receivers shall be located in preset dimming control stations, scene selection control stations, and in separate ceiling mounted receivers. Ceiling mounted receivers shall have a 360 degree range. Receivers shall be provided as recommended by the manufacturer for complete coverage of the room for control of lighting from the center platform. Remote control stations that do not reliably operate the lighting controls from this location shall not be acceptable, and shall be replaced by the manufacturer.

4) Provide two hand held remote transmitters.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which the dimming system are to be installed, including supporting of dimming panels. Do not proceed with work until method of installation is in a manner acceptable to the manufacturer and to the Contractor.
B. Inspect each installed control station for damage. Replace damaged control stations and components.

C. Give advance notice of dates and times for field tests.

D. Tests: Verify normal operation of each dimmer and control station after system has been installed and circuits energized with normal power source.

E. Replace or repair malfunctioning dimmers and components, then retest. Repeat procedure until all units operate properly.

3.2 INSTALLATION

A. Install dimming system in accordance with applicable requirements of the NEC, NECA's Standard of Installation, NEMA standards, and with recognized industry practices to ensure that the architectural dimming system fulfills project requirements.

B. Each system component shall be packaged with complete instructions and illustrations on installation. Install system in strict conformance with manufacturer's recommendations and instructions.

C. Install architectural dimming system after building is enclosed, weathertight, and environmental conditions are nominally the same as expected for the completed spaces.

D. Coordinate with other electrical work and contractors as appropriate to properly interface installation of architectural dimming system with other work.

E. Install control stations at heights scheduled, and as indicated on drawings. Install wall stations vertically on latch side of door within 6" of frame edge, unless otherwise noted.

F. Install ceiling remote receiver stations as recommended by the manufacturer.

G. Verify station locations prior to rough-in.

H. Install stations and dimmers plumb and level with finished surfaces.

I. Control wiring shall be low voltage, Class II wiring, electrically isolated from power wiring by a U.L. listed Class II transformer.

J. All wiring shall be in conduit.

K. Provide a separate neutral conductor for each dimmer.

L. Contractor shall reinforce wall as required for wall mounted panels.

3.3 FIELD QUALITY CONTROL

A. Upon completion of the installation and prior to feeding loads through the dimmers, the Electrical Contractor shall completely test all line voltage power and low voltage control wiring
for continuity and accuracy of connections. The bypass shall remain in place until all loads have been fully tested and found to be free of mis-wires, short circuits, or other wiring defects.

B. The system shall be completely checked out by a manufacturer’s factory-trained representative with the presence of the Specifying Engineer and Architect. The check-out will be performed upon notification by the Contractor that the system installation is complete. The manufacturer’s representative shall instruct the Owner for 8 hours on the system capabilities, operation, and maintenance.

3.4 ADJUSTING AND CLEANING

A. Clean control stations upon completion of installation. Use methods and materials recommended by manufacturer. Stations with dust, dirt, scratches, or fingerprints shall not be acceptable.

B. Check dimmer preset control for proper operation.

C. Verify that dimmers function without producing lamp flicker or audible noise.

D. Verify that dimmers function without interference of audio and visual equipment.

E. Verify proper operation of remote control transmitters and receivers from all presenter locations in the room. Unreliable operation of the system shall not be accepted.

3.5 DEMONSTRATION

A. Upon completion of the installation of the preset dimming system after the normal power source has been energized, test each control station with the Architect and Owner present to demonstrate capability and compliance with specification requirements.

3.6 GROUNDING

A. Provide equipment grounding connections for dimming system in accordance with NEC requirements and manufacturer's recommendations.

END OF SECTION 26 0933
SECTION 26 0943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference lighting control devices specified herein.

C. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0923: Lighting Control Devices

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section includes manually operated lighting controls with relays.

B. Section includes manually operated, PC-based, digital lighting controls with external signal source relays.

C. Related Sections:
   1. Division 26 Section "Lighting Control Devices" for time clocks, photoelectric sensors, occupancy sensors, and multipole contactors.

1.4 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.

B. BAS: Building automation system.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

F. PC: Personal computer; sometimes plural as "PCs."

G. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

H. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.

I. UTP: Unshielded twisted pair.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and plates, and conductors and cables.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
   3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
   4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
   2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

D. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.
4. Printout of software application and graphic screens.

E. Field quality-control reports.

F. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

G. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of lighting control functions.

2. Coordinate lighting controls with BAS and HVAC controls. Design display graphics showing building areas controlled; include the status of lighting controls in each area.

3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

B. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of software input/output to execute switching or dimming commands.
b. Failure of modular relays to operate under manual or software commands.
c. Damage of electronic components due to transient voltage surges.

2. Warranty Period: Two years from date of Substantial Completion.
3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
4. Extended Warranty Period for Electrically Held Relays: Ten years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Extra Stock: Deliver replacement stock directed to Owner's storage space, and obtain receipt.
   1. Relays: 10 relays for each 100 of each type and rating installed. Furnish at least 1 of each type.
   2. Low Voltage Switches: 1 for each 100 of each type and rating installed. Furnish at least 1 of each type.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of the software.

   1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. Watt Stopper/Legrand
   2. Lighting Control and Design
   3. Cooper Controls
   4. Philips Controls
2.2 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

B. Performance Requirements: Manual switch operation sends a signal to network-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

C. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.

1. ASHRAE 135 (BACnet), LonTalk, or Modbus communication interface with the BAS shall enable the BAS operator to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

D. Emergency Requirements: Relay panel shall be UL 924 listed. Relays designated for connection to emergency source loads shall operate with standard switching functions under normal power. Under loss of normal power to panel, the designated relays connected to emergency source loads shall fail closed. External transfer devices shall not be used to achieve this switching function unless noted otherwise on drawings.

2.3 CONTROL MODULE

A. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.

B. Control Module Description: Comply with UL 508 (CAN/CSA C22.2, No. 14); microprocessor-based, networked, control unit; mounted in preassembled, modular relay panel. Low-voltage-controlled, latching-type, single-pole lighting circuit relays shall be prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays. Control units shall be capable of receiving inputs from sensors and other sources. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable.

1. Interoperability: Control module shall be configured to connect to LonWorks, BACnet, or Modbus - compliant network, resulting in extending control to any network-compliant devices such as occupancy switches.

2. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.
3. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.

4. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.

5. Astronomic Control: Automatic adjustment of dawn and dusk switching.

6. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over data links. System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.

7. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.

8. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override.

9. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.

10. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.

11. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.

12. Additional Programming: In addition to system programming by the PC, individual control modules shall be networked and programmable using data-entry and retrieval (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs.

2.2 POWER DISTRIBUTION COMPONENTS

A. Modular Relay Panel: Comply with UL 508 (CAN/CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1. Cabinet: Steel with hinged, locking door.
   a. Barriers separate low-voltage and line-voltage components.
   b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
   c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
   a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
   c. Endurance: 50,000 cycles at rated capacity.

B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

2.3 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES

A. Connection Type: RS-485 protocol, category 6 UTP cable, using RJ45 connectors. Power shall be from the control unit.

B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.

1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Division 26 Section "Wiring Devices."

2. Multi-Gang Mounting: One to six pushbuttons per gang.

2.4 CONDUCTORS AND CABLES

A. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 6 for horizontal copper cable and with Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.


1. For power wiring comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables"

2. For digital data transmission and low-voltage (operating at less than 50 V) remote control and signaling cables, comply with Division 26 Section "Control-Voltage Electrical Power Cables"

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

E. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

G. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. Test for circuit continuity.
   2. Verify that the control module features are operational.
   3. Check operation of local override controls.
   4. Test system diagnostics by simulating improper operation of several components selected by Architect.

E. Lighting controls will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.3 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. See Division 01 Section "Demonstration and Training."

END OF SECTION 26 0943
SECTION 26 1900 - DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of this section include raceways, electrical boxes and fittings, wiring/cabling, and control/signal amplification and transmission media, as specified in applicable Division 26 Common Work Results for Electrical sections, that are used in conjunction with installation of this system.

1.2 SUMMARY

A. This Section includes fire alarm systems. It includes requirements for system components including the following:

2. Smoke detectors.
3. Duct detectors.
5. Horns.
7. Door holders.
8. Fire alarm control panel (FACP).
9. Device location indicating lights.
10. Addressable interface units.
11. Annunciator.
12. Emergency power supply.
13. Single/Multi-Station Smoke Detectors

B. Related Sections: The following Division 21 and 23 Sections contain requirements that relate to this Section:

1. Division 21 Section FIRE SUPPRESSION for water flow, pressure, or tamper switches connected to fire alarm system.
2. Division 23 Section INSTRUMENTATION AND CONTROL FOR HVAC for duct smoke detectors.
3. Division 23 Section SEQUENCE OF OPERATION FOR HVAC CONTROLS for duct smoke detectors.

1.3 DEFINITIONS

A. Alarm Initiating Device: A manual station, smoke detector, heat detector, or sprinkler water flow switch.
B. Alarm Signal: Signifies a state of emergency requiring immediate action. Pertains to signals such as the operation of a manual station and the operation of a sprinkler system flow switch.

C. Class A (style D & Z) Wiring: Circuits arranged and electrically supervised so a single break or single ground fault condition will be indicated by a trouble signal at the FACP and the circuit will continue to be capable of operation for its intended service in the faulted condition no matter where the break or ground fault condition occurs.

D. Class B (style B & Y) Wiring: Circuits electrically supervised such that a single break or a single ground fault condition will be indicated by a trouble signal at the FACP no matter where the break or ground fault condition occurs. Only devices that are electrically further than the fault will be inoperative.

E. Supervisory Signal: Indicates need for action regarding fire suppression or other protective system.

F. Trouble Signal: Indicates that a fault, such as an open circuit or ground, has occurred in the system.

1.4 SYSTEM DESCRIPTION

A. General: Non-coded, addressable, microprocessor based type system with manual and automatic alarm initiation, analog addressable smoke detectors, and automatic alarm verification for alarms initiated by certain smoke detectors as indicated.

B. Signal Transmission: Multiplex signal transmission dedicated to fire alarm service only.

C. Alarm Notification:
   1. By audible notification of appliances sounding a “Synchronized” Temporal "Code 3" as required by NFPA 72, Chapter 6, paragraph 6.8.6.4.
   2. By a “Synchronized” flashing the visual notification appliances.

D. System connections for alarm initiation and alarm indicating circuits: Class B wiring.

E. Functional Description: Provide a complete fire alarm and detection system with the following functions and operating features:

   1. Signal Initiation: The activation of any manual or automatic fire alarm initiating device shall cause the following actions and indications:

      a. The common alarm LED shall flash on the Fire Alarm Control Panel and at all Remote Annunciators as shown on the Drawings.
      b. Display a custom message describing the device originating the alarm condition at the Fire Alarm Control Panel and at the Remote Annunciators on the LCD alpha numeric displays. All displays shall be identical including those at the remote locations. These displays shall display the alarm condition via unique messages as required by the system Owner.
c. The audible notification appliances shall sound a “Synchronized” temporal pattern (Code 3) alert tone, this as outlined by NFPA 72 Section 6.8.6.4, on all the audible devices throughout the building.

d. The visual notification appliances shall flash throughout the building. All visual devices in that area shall be synchronized to flash at the same time.

2. Off Premise Transmission: Alarm, Troubles and Supervisory Alarm signals shall be transmitted to a U.L. Central Station as approved by the Authority Having Jurisdiction.

   a. The selection of the Central Station shall be by the Owner and is not part of this Contract. However, this contractor shall coordinate the connection for this service including performing all programming of the communication device to ensure the alarm is transmitted and received by this Agency.

   b. Off site trouble reports for primary system failure shall be automatically delayed for a period of time equal to 25% of the system standby battery capacity to eliminate spurious reports as a result of power fluctuations.

3. Silencing: Switches shall be provided to acknowledge and silence alarm, trouble and supervisory conditions at the Fire Alarm Control Panel or at any Remote Annunciator equipped with an LCD Display. Activation of these shall silence the audible appliances and the visual appliances shall stop flashing. The alarm indication shall be transferred to a solid visual indicator on the control panel and at all remote annunciators.

   a. The alarm signals shall resound and strobes will continue to flash upon receipt of a subsequent alarm condition, reported by a different device.

   b. A signal dedicated to sprinkler system water flow alarm shall not be silenced while the sprinkler system is flowing at a rate of flow equal to a single head.

4. Trouble Indication: Any abnormal condition, such as loss of primary power, open circuit, or a grounded conductor shall cause the system trouble signal to sound and the trouble LED to glow indicating the type of trouble that exists. The trouble signal may be silenced by momentarily depressing the trouble silence switch, but the trouble LED shall glow until the trouble condition has been corrected. If a second trouble condition should arise, the trouble signal shall be resounded.

5. Power Sources: The system shall normally operate from a single 120VAC 60 Hz source, however, standby batteries shall be provided to operate the system during power outages. Batteries shall be sized to operate the system in the standby mode for a minimum of 60 hours and in the alarm mode for a minimum of 5 minutes at the end of the 60 hour period.

6. Power Loss Indication: Sound trouble signal at the FACP upon loss of primary power at the FACP. Provide an indication at the FACP when the system is operating on an alternate power supply.

7. Annunciation: Annunciate manual or automatic operation of any alarm or supervisory initiating device both on the FACP and on the annunciator indicating the location and type device.

8. FACP Alphanumeric Display: Liquid crystal (LCD) display.

9. General Alarm: A system general alarm includes:

   a. Indicating the general alarm condition at the FACP and at all Remote Annunciators equipped with an LCD Display (Refer to the Drawings).
b. Display the custom message describing the device originating the condition at the Fire Alarm Control and at the Remote Annunciators on the LCD alphanumeric displays. The custom messages shall be approved by the system Owner before programming.

c. Initiating audible and visible alarm signals throughout the building.

d. Activation of any smoke detector in an elevator lobby or an elevator equipment room shall, besides the actions described, cause the recall of that bank of elevators to the terminal floor and lockout the elevator controls. In the event of recall initiation is by lobby detector on the terminal floor, the recall shall be to the alternate floor. The recall floor shall be as defined by the Authority Having Jurisdiction. This contractor shall coordinate this connection with the elevator supplier. The Control Modules and Monitoring Modules required to perform this function shall be provided even if not shown on the contract drawings.

e. Activation of any heat detector in an elevator shaft or an elevator equipment room shall, besides the actions described, shall shut down elevator power in accordance with section 6.15.4 of NFPA 72. All control circuits to shut down elevator power shall be monitored for the presence of operating voltage by the fire alarm system as required by paragraph 6.15.4.4 of NFPA 72. The Control Modules and Monitoring Modules required to perform this function shall be provided even if not shown on the contract drawings.

f. For each elevator a fire alarm system addressable control module shall be provided for to operate the elevator’s visual warning signal located in the elevator cab, which shall operate in response to the activation of the fire alarm initiating devices located in the elevator machine room or those located in the elevator shaft. The Control Modules and Monitoring Modules required to perform this function shall be provided even if not shown on the contract drawings.

g. Closing fire and smoke doors normally held open by magnetic door holders.

h. Stopping supply and return fans serving area where the alarm initiated.

i. Closing smoke dampers on system serving area where the alarm initiated.

j. Initiating smoke control sequence through a signal to the building automatic temperature control system.

k. Unlocking designated doors.

l. Initiating transmission of alarm signal to remote central station.

F. Manual station alarm operation initiates a general alarm.

G. Water flow alarm switch operation:

1. Initiates a general alarm.

H. Smoke Detection:

1. Smoke detection initiates a general alarm.

2. Smoke Detection for devices without Alarm Verification initiates a general alarm.

3. Smoke Detection for a Device With Alarm Verification Causes:

   a. Audible and visible indication "alarm verification" signal at the FACP.

   b. Activation of a listed and approved "alarm verification" sequence at the FACP and the detector.

   c. Recording of the event on the system printer. (A SYSTEM PRINTER IS AN OPTIONAL DEVICE)
d. General alarm initiation if the alarm is verified.

e. FACP indication canceled and system reset if the alarm is not verified.

I. Sprinkler valve tamper switch operation:

1. Causes a supervisory audible and visible "valve tamper" signal indication at FACP and remote annunciator.

2. Display the custom message describing the device originating the condition at the Fire Alarm Control Panel, the Remote Fire Alarm Control Panels and at the Remote Annunciators on the LCD alpha numeric displays. The custom messages shall be approved by the system Owner before programming.

J. Low-air pressure switch operation on a dry pipe or preaction sprinkler system:

1. Causes a supervisory audible and visible "sprinkler trouble" signal indication at FACP and remote annunciator.

2. Display the custom message describing the device originating the condition at the Fire Alarm Control Panel, the Remote Fire Alarm Control Panels and at the Remote Annunciators on the LCD alpha numeric displays. The custom messages shall be approved by the system Owner before programming.

K. Remote Detector Sensitivity Adjustment: Manipulation of controls at the FACP causes the selection of specific addressable smoke detectors for adjustment, displays of their current status and sensitivity settings, and controls changes in those settings. Provide ability of using the same controls to program repetitive scheduled changes in sensitivity of specific detectors.

L. Permissible Signal Time Elapse: The maximum permissible elapsed time between the actuation of any fire alarm or fire detection system alarm initiating device and its indication at the FACP is two seconds.

M. Independent System Monitoring: Supervise each independent smoke detection system, duct detector, and elevator smoke detection system for both normal operation and trouble.

N. Circuit Supervision: Indicate circuit faults with both a device identification and a trouble signal at the FACP. Provide a distinctive indicating audible tone and (LED) indicating light. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP is 200 seconds.

1.5 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Provide documentation of staff experience, certification, and business history.

1. Evidence that the technicians that are to oversee the project including but limited to commissioning and testing the system are NICET Level 2 Certified.

C. Product data for fire alarm system components including dimensioned plans, sections, and elevations showing minimum clearances, installed features and devices, and list of materials.
This product data shall include a complete listing of wire being proposed for the installation with all the corresponding specification sheets.

D. System submittals shall include plan, riser and wiring diagrams complete with all wiring and required equipment.

E. Complete drawings including the following shall be submitted by the Contractor for the purposed system:

1. Floor plans showing all initiating, end of line, supervisory, indicating appliances, and output control devices; including circuit interface panels, annunciators, supplementary power supplies and the main CPU locations. Raceways shall be shown, marked for size, conductor count with type and size, meeting the percentage of allowable National Electric Code fill used.

2. Drawings shall indicate ambient sound levels used by the system layout designer for sound level calculations and mathematical justification for signal placement to meet the code requirement of 15 dBA above ambient for audible warning signals. (Refer to NFPA 72, Chapter 7 for the complete design criteria.)

3. Drawings shall indentify the “Candela” of each visual notification appliance (Strobe), which shall be in accordance with the spacing and effective light intensity identified in Tables 7.5.4.1.1(a) and 7.5.4.2.2(b) of NFPA 72.

4. Wiring diagrams showing points of connection and terminals used for all electrical connections to the system devices and panels.

F. The contractor shall include the following calculations in the equipment submittal:

1. Power calculations:
   a. Battery capacity calculations. Supervisory power requirements for all equipment.
   b. Alarm power requirements for all equipment.
   c. Justification showing power requirements of the system power supplies.
   d. Voltage drop calculations for wiring runs in worst case conditions.

2. Circuit loading calculations.
   a. Initiating device circuits (IDC). Only a single initiating device shall be installed on each IDC so that each device is uniquely identified on the system. Provide calculations indicating this requirement is met.
   b. Notification appliance circuits (NAC) shall have a load under 75 percent of its rating. Provide calculations indicating this requirement is met.
   c. Signaling line circuits (SLC) shall have a load under 80 percent of its rating. Provide calculations indicating this requirement is met.

G. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make a simultaneous identical submission to the authority having jurisdiction. Include copies of annotated Contract Drawings as required to depict component locations to facilitate review. Upon receipt of comments from the authority, submit a copy of the marked-up submittal for review. Make resubmissions to the authority if required to make clarifications or revisions to obtain approval. Provide documentation verifying that this submission has been made. This shall be in accordance with Paragraph 907.1.1 of the 2009 Edition of the
“International Building Code” (IBC) along with any and all Amendments adopted by the local municipality.

H. A complete proposed system database including a description of all logic strings, control by event programming and point identification labels on CD-ROM and in a formatted printed form, required for off site editing, uploading and downloading shall be submitted for evaluation by the Owner.

1. A programming manual shall accompany the submitted program and shall be adequate to allow understanding, operation and editing by the system Owner.

I. To avoid delays in the progress of the project, submittal proposing substitutions to the specified equipment shall be provided for evaluation within seven (7) days of the award of the contract.

1. A single elevation of substitute submittal data will be provided for proposed substitutes. Any required resubmittal will be elevated and charged to the contractor at the normal hourly billing rates for the design Architects and Engineers services.

1.6 RECORD DOCUMENTS

A. Provide maintenance data for materials and products, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 26 Section "Basic Electrical Requirements." Provide complete manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover.

1. Provide to the Owner three (3) "Operation and Maintenance Manuals".
2. These shall be provided in 3-ring binders with the following information inscribed on the cover:
   a. "OPERATION AND MAINTENANCE MANUAL"
   b. Building location.
   c. The name and telephone number of the contractor, system manufacturer, and system subcontractor.

3. The manual shall be legible and easily read with large drawings folded and contained in pockets.
   a. Included in the manual shall be circuit drawings, wiring and control diagrams with data to explain detailed operation and control of each item and a control sequence describing start up instructions.
   b. Included shall be installation instructions, maintenance instructions, safety precautions, test procedures, performance data, and software documentation.

B. Provide the name, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.

C. Provide both a "Certificate of Completion" as outlined in Chapter 4, Section 4.5 of NFPA 72 and the "Inspection and Testing Form" as outlined in Chapter 10, Section 10.6 of NFPA 72.
Each shall be fully executed by the manufacturer's representative and the local building inspector.

D. Provide complete system wiring diagrams detailing 'as built' wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

E. Provide system record drawings and wiring details including one set of reproducible masters and drawings on CD-ROM in a DXF format suitable for use in a CAD drafting program.

F. Provide a copy of the system program identifying all system functions, controls and labeling of equipment and devices on a CD-ROM which allows for program editing and in printed format.

1.7 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer Qualifications: The Contractor shall retain and pay for the services of a factory-trained NICET Certified, technical representative of the system manufacturer to supervise the installation of the system and to verify that the system has been installed and is functioning properly. The technical representative shall furnish installation drawings and technical assistance to the Installing Contractor. At the completion of the installation, the Technical Representative shall completely test the system including each initiating device and signaling device and each circuit of the system shall be tested for trouble reporting. Documentation shall be provided to the Owner and authority having jurisdiction that these tests were completed. The documentation shall list each device of the system, when it was tested, and the name of the Technical Representative.

C. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

D. NFPA Compliance: Provide Fire Alarm and Detection System conforming to the following National Fire Protection Association (NFPA) standards:

1. NFPA 13 "Standard For the Installation of Sprinkle Systems".
   a. NFPA 13A "Recommended Practice For The Inspection, Testing And Maintenance of Sprinkler Systems".
   b. NFPA 70 "National Electrical Code".
   c. NFPA 72 "National Fire Alarm Code".
   d. NFPA 90A "Standard For the Installation of Air Conditioning And Ventilating Systems".
   e. NFPA 101 "Life Safety Code".

E. IBC: Components and installation shall comply with "International Building Code".
F. UL Listing and Labeling: Provide system and components specified in this Section that are listed and labeled by UL.

G. State and Local Building Codes as adopted by the Authority Having Jurisdiction (AHJ).


J. American Society of Mechanical Engineers (ASME)

K. National Institute for Certification in Engineering Technologies (NICET).

L. Prior to commencing with the installation of the fire alarm system, this contractor shall submit the plans for the fire alarm system to the local Authority Having Jurisdiction for approval. This contractor shall pay all fees associated with this approval including the fee for all inspections.

1.8 MAINTENANCE SERVICE

A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months commencing with Substantial Completion, using factory-authorized service representatives.
   1. Basic services: Respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
   2. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

1.9 EXTRA MATERIALS

A. General: Furnish extra materials matching products installed, as described below, packaged with protective covering for storage, and identified with labels clearly describing contents.

B. Manual Stations: Furnish quantity equal to 3 percent of the number of units installed, but not less than two (2).

C. Strobe Units: Furnish quantity equal to 3 percent of the number of units installed, but not less than two.

D. Smoke Detectors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 3 percent of the number of units of each type installed but not less than two (2) of each type.

E. Detector Bases: Furnish quantity equal to 2 percent of the number of units of each type installed but not less than two (2) of each type.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In order to assure the Owner of all factory warranties, all equipment shall be obtained from an approved factory authorized distributor. The manufacturer and/or his authorized distributor shall show satisfactory evidence that he maintains a fully equipped factory authorized service organization, stocked with factory approved replacement parts within 50 miles of the project site and is capable of furnishing adequate inspection and service of equipment.

B. The catalogue numbers specified herein are those of Siemens and constitute the type and quality of equipment to be furnished. The system shall be complete in every respect including all necessary equipment shown or now shown on the drawings to perform the functions relative to the system operation. All published specifications of the above manufacturer shall be considered as part of this specification even though they may not be shown in complete detail.

C. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Siemens
2. SimplexGrinnell
3. Edwards Systems Technology (EST)

2.2 FIRE ALARM CONTROL PANEL

A. The fire alarm control panel shall be Siemens Model MXL, modular in construction and shall include, but not limited to; the hardware, software and firmware required to perform the following major system functions:

1. Surface or recessed mounted steel cabinet, as shown in the drawings, with indicator viewing window, hinged door and cylinder lock, dead front construction, and factory finished in baked enamel.

2. System power supplies, including necessary transformers rectifiers, regulators, filters and surge protection required for system operation, with the capacity to power the system in the worst case condition with all devices in alarm and all local indicating appliances active without exceeding the listed ratings. The system devices shall display normal and alarm conditions consistently whether operating from normal power or emergency (standby) power.

3. System 16 bit core processor, with internal operating system processing incoming alarm as a result of the alarm reception by system programming or manual commands. Total system response time shall not exceed 2.5 seconds on a system configured to the maximum capacity. All system processors shall be supervised by individual watchdog circuitry furnishing automatic restart after loss of activity. Systems with a single watchdog circuits for all processors shall not be acceptable.

4. Selectable Style "4" of Style "7" system digital communication capabilities required for the control panel to communicate with remote circuit interface panels, annunciators, and displays. All communications shall be conducted in a digital format. Systems processing signals using pulse width or voltage level techniques are not considered acceptable. Provide Siemens Model NET-4 for "Style 4".
5. Selectable Style "4", Style "7" with loop isolator analog signaling circuitry required to communicate with, and receive alarms from 120 points, consisting of a maximum of sixty intelligent analog alarm initiating and sixty intelligent controllable output devices. Provide Siemens Model ALD-2I analog loop driver.

6. Detection line circuit monitoring shall be provided by a Conventional Zone Module, Model CZM-4. This module shall be system interconnected by a card edge connector and shall be operated by the MXL control panel. Each circuit shall be capable of Style "D" or Style "B" wiring. Style "B" wiring shall require an end of line device. Each zone shall accommodate up to thirty (30) Pyrotronics ionization or photoelectric detectors, flame and beam detectors, as well any quantity of shorting type contact devices.

7. An output circuit for operation for DC (coded if required) audible devices, leased line or city tie shall be provided by an addressable Controllable Signal Module, Model CSM-4. This addressable module shall be system interconnected by a card edge connector, capable of operating with either Style "Y" or Style "Z" wiring, and shall be operable by the MXL or remote control panel. All Style "Y" indicating circuits shall require and be fitted with an end-of-line device. The output current shall be at 1.5 amps maximum per circuit, and each circuit shall be fused separately. The module shall be supervised by the MXL or MXLR for open and shorted circuits. Open and short circuits shall report trouble only and respond with circuit identification.

   a. The module shall contain two (2) programmable open collector outputs capable of sourcing 250 ma at 40 VDC for relay or LED activation.

8. For control of air handling units, BMS interface, and elevators there shall be provided a Controllable Relay Module, Model CRM-4. The module shall be system interconnected by a card edge connector and shall be operable by the MXL and remote control unit. It shall contain four independent relays, fitted with form "C" contacts, rated at 2 amps 28VDC/120 VAC resistive. All relays shall be supervised for coil open or shorted conditions.

9. Motherboards shall be used to plug in the specified modules for system expansion. Motherboard shall be Siemens Model MOM-4.

10. The enclosure for the system shall provide complete dead front construction. Human interface modules shall be on a frame hinge mounted to provide easy access to wiring and system plug-in cards. Enclosure door shall be pin hinged and removable, for easy system operation by fire fighters, and technicians in testing, and maintenance modes.

11. The system shall include chronoLINK for system data base, historical event log, logic, and operating system. The system shall require no manual input to initialize in the event of a complete power down condition. It shall return to an on-line state as an operating system performing all programmed functions upon power restoration. Systems requiring battery backed-up memory devices shall not be acceptable.

12. System display consisting of an 80 character back lighted alphanumeric super twist LCD display readable at any angle. Thirty-two character customer defined custom messages shall describe the location of the device.

   a. As an option for local protective signaling systems, the system shall be capable of programming to allow troubles occurring and restored in the system to be automatically removed from the display queue, eliminating the necessity for individual acknowledging of these events. This feature shall not affect the historical logging of events as programmed.
b. As a minimum, an LED display for "ALARM", "AUDIBLES SILENCED", "SUPERVISORY", "TROUBLE", "SECURITY", "POWER ON" and "PARTIAL SYSTEM DISABLED".

c. Touch activated membrane switches for "ALARM ACKNOWLEDGE", "AUDIBLE SILENCE", "SUPERVISORY ACKNOWLEDGE", "TROUBLE ACKNOWLEDGE", "SECURITY ACKNOWLEDGE", "RESET", "DISPLAY HOLD" and "DISPLAY NEXT".

d. All membrane switches shall be tactile with audible feedback when pressed.

e. Touch activated membrane switches, programmable to perform a minimum of 12 custom functions such as drill, disable, bypass automatic control commands or other special functions as required by the system user or authority having jurisdiction.

f. Ten digit keypad for the pass code entry to perform programming and maintenance functions.

g. The system shall have the ability to have additional MKB-2's as remote annunciators or remote control points. Up to four (4) supervised MKB-2 annunciators may be in the system. Each supervised MKB-2 can have slave MKB-2's connected to them up to the system maximum. Each MKB-2 with a PIM-1 card can have devices such as; Printers, Video Display Terminals, Color Video Display Terminals, or CRT's.

13. Conventional zone modules as required in Style "B" or Style "D" for the operation and supervision of a minimum of 30 compatible two wire detectors per zone.

14. Programmable panel relays programmed to perform control functions required for system operation described in this specification and shown on the drawings.

15. Software defined logic module as required for each alarm initiation point, capable of controlling any combination of the system output functions using as logic factors; counting, verification, time, day, holiday, type of device, "and", "or", "not", "timer", "all", "any", flip-flop, D latch, and up to 32 levels of programming shall be possible.

16. Software logic modules and system database shall be programmed using a DOS compatible program on any IBM compatible computer. It shall be possible to program or edit the system database off site after downloading from the control panel.

17. Selective chronolINK, up to 800 events, shall be stored in flash memory and displayed, printed or downloaded by classification for selective event reports.

a. AccuLINK shall allow selection of events logged, including; inputs as alarms, troubles, status changes, supervisories, securities, and device verification; outputs as audible control and output activation; actions as reset, set sensitivity, arm/disarm, override, password, set time and acknowledge.

b. Data format for downloading shall be compatible with the data base handling program, Paradox by Borland, allowing custom report generation to track alarms, troubles, and maintenance.

c. Audible and visual indications shall be generated when memory is 80% and 90% full to allow downloading of data. The system shall be programmable circular logging, assuring that at least the last 400 events will always be stored in non-volatile memory.

18. EviroLINK software driven logic for adjusting the alarm threshold windows on detectors to compensate for accumulating contamination and keep detector response sensitivity constant. The software shall compensate for either over-sensitized or de-sensitized units, raising a system flag when a detector approaches the allowable limits of adjustment, indicating a requirement for cleaning.
a. EnviroLINK values shall be stored in non-volatile memory allowing activation of all tracking functions within 90 seconds of system initiation from a "cold boot". During the boot sequence, alarms from detectors programmed with the feature shall be suppressed. When the full data history is active, all devices shall be checked and any active alarms displayed.

b. The control panel shall place each detector in the system in an alarm condition, transparent to the system user, every 24 hours as a dynamic check of the accuracy of the alarm threshold setting. Upon reception of the alarm report, the system detector shall be restored to its pretest state.

c. The system shall be capable of monitoring the state of detectors and displaying a message when a detector is approaching the limits of adjustment as a result of contaminates. A second message shall be displayed when the detector reaches the limits of adjustment due to these contaminates.

d. The system shall be capable of recognizing that a detector has been cleaned, initiating a series of tests to determine if the cleaning was successful and display a detector cleaned message, readjusting that detectors normal sensitivity setting reference.

2.3 FIRE ALARM SYSTEM POWER SUPPLIES

A. System Primary Power:

1. Primary power for the FACP shall each be obtained from the panelboard as shown on drawings and schedules. Circuit breakers shall be fitted with a suitable guard, requiring removal of a screw to open, and used only for fire alarm. Each circuit used for fire alarm purposes shall be permanently labeled for function.

2. The MXL power supply and battery charging shall be provided by the MMB-1 main board and an MPS-6 power supply.

3. The MXLR (FA) power supply and battery charger shall be provided by the PSR-1 remote power supply and an MPS-6 or MPS-12 power supply.

B. Emergency Power Supply:

1. Provide sealed gelled electrolyte batteries as the secondary power supply for the fire alarm control panel and each system circuit interface panel. The battery supply shall be calculated to operate its load in a supervisory mode for sixty (60) hours with no primary power applied and, after that time, operate in the alarm mode for five (5) minutes. Batteries shall be sized at no larger than 80% of the calculated size to compensate for deterioration and aging during the battery life cycle. Battery calculations shall be submitted as part of the submittals to ensure these requirements are met. Batteries shall be housed in the control cabinet or a separate cabinet with adequate cell separation to prevent accidental discharge.

a. Magnetic door holders shall not be served by emergency power. Magnetic door holders shall be released on the failure of primary power.

2. Provide battery charging circuitry and battery for each system power supply in the system. The charger shall be automatic in design, adjusting the charge rate to the condition of the batteries.
a. Battery charge rate and terminal voltage shall be read using the fire alarm control panel LCD display in the service mode in volts and amps. Meters reading in percentage are not acceptable. Charger shall be housed in the main fire alarm control panel or the battery cabinet.

C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide for 150 percent of the connected system load while maintaining the batteries at full charge. In the event batteries are fully discharged, the charger shall recharge them to 70 percent of full charge in 12 hours. Charger output shall be supervised as part of system power supply supervision.

2.4 REMOTE ANNUNCIATORS (FAAP)

A. The annunciator shall provide full system control and display all system activity. Any and all functions and display information provided at the main fire alarm control panel, shall also be provided at the remote annunciators.

B. It shall include a Siemens MKB display/keypad, a PS-5N network power supply and an enclosure with lockable door. The door shall restrict access to the command and function switches to prohibit unauthorized operation. The annunciator shall be powered from the MXL or an MXLR as shown on the drawings. The annunciator shall be a Siemens Model RCC-1F remote command center.

2.5 INTELLIGENT SMOKE DETECTORS

A. Furnish and install where indicated on the drawings, Siemens type FP-11, Intelligent analog smoke detectors with features and characteristics as follows:

1. The detector shall be Application Specific Detectors (ASD). Each smoke detector shall include a microprocessor that automatically checks the detector’s calibration, performs sensitivity checks, sensitivity adjustments, monitor’s the detector’s sampling chamber for the build up of contaminants and application specific detection software to speed detection of a real fire phenomena and reject deceptive phenomena.

2. The smoke chamber of the detector shall effectively manage light dissipation and extraneous reflections from dust particles or other airborne contaminants in such a way as to maintain stable consistent detector operation. The detector shall incorporate FirePrint software technology enabling the detector to be programmed for the environment in which it is installed. The system shall automatically set the detector’s “Alarm” and “Pre-Alarm” points as well as calculation factors for weighting input from the detector’s sensors. The detector shall operate at set factory defined default if the operator or should the installer fail to program the detector.

3. The detector shall be capable of bi-directional communication with the control panel and shall be dynamically supervised and uniquely identifiable by the control panel. The control panel shall be capable of analyzing the signal for the detector’s analog value for calibration, sensitivity and address identification. These values shall be displayed upon command from the control panel as well as the detector’s application program setting. The detector’s sensitivity or application setting shall be individually controlled at the control panel. Should the detector’s sensitivity voltage shift beyond an acceptable level and remain there for a predetermined duration, a detector trouble signal shall be annunciated at the control panel identifying the detector.
4. Each detector shall contain a multi-color LED indicator which shall flash Green every four seconds indicating a “Normal Condition”, Amber to indicate a “Detector Fault”, and Red when instructed by the Fire Alarm Control Panel to indicate an “Alarm Condition”.

5. The detector shall be addressed, tested and programmed prior to installation using a UL listed programmer/tester. The detector readout shall yield a discreet electrical value for status tracking and logging for determining maintenance and cleaning requirements.
   a. The control panel shall provide detector “Sensitivity” readout from the detector without removal from the pluggable base.
   b. Detectors not specifically listed for sensitivity testing from the control panel are not acceptable due to the expense involved with manual testing as required by NFPA 72.

6. The detector shall be suitable for two-wire operation and two-way communications on the intelligent analog signaling circuit.

7. The detectors furnished shall be listed for use in environments as covered by Factory Mutual, UL (UROX) and shall be installed according to the requirements of NFPA 72 for open area coverage.

2.6 DUCT DETECTORS

A. The detectors for duct detector applications shall be installed in a Siemens AD2-XHR with an addressable relay.

B. As part of this contract, this contractor shall coordinate with the HVAC Contractor on the proper selection of the air sampling tubes.

C. The duct smoke detectors shall be supplied by Electrical Contractor, installed by Heating Contractor, and wired by Electrical Contractor.

D. The sensors shall meet the requirements of UL Standard 268A and shall be documented compatible with the control equipment to which they are connected.

E. The addressable duct smoke sensors shall operate on the light-scattering, photodiode principle, and shall communicate actual smoke chamber values to the system control.

F. The sensors shall not have a self-contained smoke sensitivity setting and shall automatically compensate for environmental changes.

G. The sensor's electronics shall be completely shielded to protect against false alarms from EMI and RFI.

H. The duct housing shall contain a red LED that shall pulse to indicate power-on and glow continuously to indicate an alarm or a sensor trouble condition.

I. The detector shall contain an auxiliary relay with a form "C" contact. The relay shall have a 2 ampere rating at 120VAC and 28VDC.

J. The detectors shall be installed, wired, and connected to the fire alarm control panel by the electrical contractor.
K. The detectors shall obtain their operating power from the SLC and not required an additional 24VDC from the fire alarm control panel or 120VAC from a local panel.

L. The duct detectors shall utilize cross sectional sampling principle by which a sampling tube is extended across the duct to continuously sample the air movement through the duct, after which the sampled air is returned to the duct via an exhaust tube. Sampling shall be properly sized for the duct in which it is installed.

2.7 HEAT DETECTORS, INTELLIGENT RATE COMPENSATED

A. Furnish and install where indicated in the drawings, Siemens type FPT-11 heat detectors with features and characteristics as follows:

1. Detectors shall be of the intelligent, rate compensated type rated at 135 degrees. Detectors shall be constructed to compensate for the thermal inertia inherent in conventional type detectors due to the thermal mass, and alarm at the setpoint of 135 degrees Fahrenheit.

2. The detector shall be addressed, tested and programmed prior to installation using a UL listed programmer/tester.

3. The detector shall be suitable for two wire operation and two-way communications on the intelligent analog signaling circuit.

   a. The detector shall display a steady LED when in the alarm state when the system is operating from normal or standby power.

4. Detectors shall incorporate triple technology microprocessor chips including analog, digital, and EEROM technologies on the single device.

   a. Address assignments shall be set electronically and devices requiring dip switches, rotary switches, staples or jumpers are not acceptable.

5. The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet for use in environments as covered by Factory Mutual and UL (UQGS) and shall be installed according to the requirements of NFPA 72 for open area coverage.

2.8 CONVENTIONAL THERMAL DETECTORS

A. Thermal detector shall be either 135 or 200 degree Fixed Temperature detector as indicated on the drawings. The detector shall be a Siemens DT series detector. These shall be connected to the fire alarm system with an intelligent interface module specified herein.

2.9 UNIVERSAL DETECTOR BASES

A. Detector bases shall be Siemens type DB-11, low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4" square or octagonal electrical outlet box.

1. Where selective localized control of electrical devices is required for system operation, furnish and install type DB-X11RS detector base with software programmed addressable
relay integral to the base. The relay shall switch electrical loads, as indicated on the drawings.

2. Furnish a concealed security lock, preventing unauthorized removal, installed in the base in those areas requiring tamper resistant installation as indicated on the drawings.

3. The detector bases shall be compatible with, and allow the installation of, detectors operating on the flame, ionization, photoelectric or rate compensated heat principles of detection.

4. At those locations indicated on the drawings, the detector base shall contain a pre-wired piezo electric drive that will produce at a minimum, an 85 dBA signal measured at 10 foot. The Audible Base shall be a Siemens model ADBX-11.

   a. The audible bases shall be programmable to sound individually or in any combination with any other audible base. (The Audible Bases shall be on a notification appliance circuit dedicated for the tenant rooms. No other strobe and/or horn shall be on this circuit.)

2.10 INTELLIGENT MANUAL STATIONS

A. Provide Siemens type MSI-10, single action intelligent manual stations.

   1. Station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring.

   2. The manual stations shall be addressable and identifiable by the master fire alarm control panel.

      a. Address assignments shall be set electronically and reside within the station in non-volatile memory. Devices using rotary switches, pins, jumpers or staples are not acceptable.

   3. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed, model SB-5R, matching baked red enamel surface outlet box.

   4. Provide a manufacturer's prescribed matching baked red enamel outlet box that is equipped with the model STI-1100 protective plexiglas cover with integral horn on all manual stations shown on contract drawings. Coordinate model of cover with physical dimensions of pull station.

2.11 REMOTE CONVENTIONAL ZONE MODULE

A. Provide, for integration of compatible 2 wire and shorting style contact devices into the analog signaling circuit, Siemens type CZM-1 intelligent analog signaling circuit interface module with the following capabilities:

   1. Communication interaction with the analog signaling circuit having the capability of reporting alarm or trouble conditions from the devices monitored.

   2. Compatibility with ionization and photoelectric and linear beam style smoke detectors, heat detectors and all listed contact type devices.

      a. The system manufacturer shall have specifically listed heat, smoke, ionization, linear beam detectors for use with the remote conventional zone module.
3. Module shall be equipped with terminal strip and pressure style screw terminals for the connection of the device and systems communications field wiring. The module shall also have an on-board alarm LED furnished with the cover plate.

4. The module shall be addressable and identifiable by the master fire alarm control panel.
   a. Address assignments shall be set electronically and reside within the module in non-volatile memory. Devices using rotary switches, pins, jumpers or staples are not acceptable.

2.12 INTELLIGENT SYSTEM INTERFACE MODULE

A. Furnish and install, for the monitoring of contact type initiation devices and for the control of electrical devices where required, Siemens Type TRI-Series intelligent analog signaling circuit interface module. Modules shall be supplied to meet the project requirements as follows:
   1. A single circuit intelligent signaling circuit interface module for monitoring alarm, trouble, supervisory security or status contact type devices, type TRIS.
   2. Unit as above with form "C" software programmable control contacts for the management of specified electrical loads as required by this specification, type TRI-R.
   3. Dual circuit units as described above, type TRI-D.

B. The module shall be addressed, tested and programmed prior to installation using a UL listed programmer/tester.

C. The module shall be suitable for two-wire, two-way communications on the intelligent analog signaling circuit.
   1. The module shall display a steady LED for each circuit, in the normal power or standby power condition, when in the alarm state or during control circuit activation.

D. Modules shall incorporate triple technology microprocessor chips including analog, digital and EEROM technologies on the single device.
   1. Address assignments shall be set electronically and devices requiring dip switches, rotary switches, staples or jumpers are not acceptable.

2.13 INTELLIGENT SUPERVISED CONTROL MODULES

A. Furnish and install for the control of supervised relays, contactors, audible signal circuits, visual signal circuits, Siemens type ICP-B6, intelligent supervisory and control modules including features as follows:
   1. The modules shall be suitable for two-wire operation and communications on intelligent analog alarm detection loops.
      a. Address assignments shall be accomplished electronically. Devices requiring dip switches, rotary switches, staples and/or jumpers are not acceptable.
   2. The module shall display a steady LED in the normal power or standby power condition, when in the activated state.
2.14 NOTIFICATION APPLIANCE DEVICES

A. Furnish and install where shown on the drawings, audible signals with the following characteristics and capacities:

1. The audible signal shall be an electronic type providing a “Synchronized” nationally and internationally recognized Temporal Tone meeting the requirement of NFPA 72 paragraph 6.8.6.4.
2. The audible signal shall produce a selectable electronic signal rated at 90 to 95 dBA measured at 10 foot and provide two (2) user programmable sound output levels; "Standard dBA" and "High dBA".

B. Furnish and install where shown on the drawings, visual signals with the following characteristics and capacities:

1. Wall mounted visual notification appliance signals (Strobes) shall be UL 1971 Listed and be complete with “The Adapter” feature providing four field selectable candela strobe settings. These shall be identified as 15, 30, 75 and 110 candela.
2. Ceiling mounted visual notification appliance signals (Strobes) shall be UL 1971 Listed and be complete with “The Adapter” feature providing four field selectable candela strobe settings. These shall be identified as 15, 30, 75 and 95 candela.
   a. For this contact the visual appliances shall be set at the candela identified by NFPA Standard 72 for area of coverage. At no time shall 15/75 candela visual notification appliances be allowed to be installed in all areas.
   b. All visual notification appliances installed in bedrooms shall be a minimum of 110 candela and located within 16’ 0” of the Bed Pillow.
   c. It shall be this contractor’s responsibility to perform the necessary calculations to determine the candela of each visual notification appliance. As part of one’s submittal complete floor plan drawings shall be provided identifying the candela of all the notification appliances.
3. The visual signals, a Xenon strobe, shall have a minimum repetition rate of 1 HZ, a maximum duty-cycle of 40% with a pulse-duration of .2 seconds and produce an unfiltered or clear filtered white light.
4. All visual signals shall be “synchronized” so that they flash in unison throughout the building.
5. Wall mounted visual signals shall be mounted such that the bottom lens is at a height of 80 inches above the highest level in accordance with Chapter 7 of NFPA 72.
6. The visual notification appliances shall be “Listed” by Underwriters Laboratory, Inc. (UL) for wall or ceiling mounting. In so long as the ceiling height does not exceed 30-feet in height, the visual notification appliances identified on the drawings to be ceiling mounted can be mounted on the ceiling. All other appliance must be mounted on the wall as identified.

C. The “Synchronized” Strobe and Combination Horn/Strobe shall operate on a single pair of wires. It shall be possible to program these devices such that the operator can “Silence” the Horns while the Strobes continue to “Flash”.

D. The evacuation signals shall be available in flush, semi-flush or surface versions as required for signal locations shown on the contract documents.
1. Common Area Notification Appliances shall be available in audible only, visual only or a combination audible/visual to satisfy all the required project applications.

   a. The “synchronized” wall mounted combination Audible /Visual Unit shall be a Siemens model ZH-MC-R. These shall mount to a 1-gang, 2-gang or 4” square standard electrical outlet box.

   b. The “synchronized” wall mounted Visual Unit shall be a Siemens model ZR-MC-R. These shall mount mounting to a 1-gang, 2-gang or 4” square standard electrical outlet box.

   c. The “synchronized” ceiling mounted combination Audible /Visual Unit shall be a Siemens model ZH-MC-CW. These shall mount to a 1-gang, 2-gang or 4” square standard electrical outlet box.

   d. The “synchronized” ceiling mounted Visual Unit shall be a Siemens model ZR-MC-CW. These shall mount mounting to a 1-gang, 2-gang or 4” square standard electrical outlet box.

   e. The “synchronized” Audible Unit shall be a Siemens model ZH-R mounting to a 1-gang, 2-gang or 4” square standard electrical outlet box.

   f. Weatherproof combination Audible/Visual Units shall be a Siemens model AS-HMC-R-WP shall be “Listed” for outdoor applications and included the model WPBBS-R Weatherproof Surface Back Box.

   g. Weatherproof Visual Units shall be a Siemens model ST-HMC-R-WP shall be “Listed” for outdoor applications and included the model WPSBBS-R Weatherproof Surface Back Box.

E. All notification appliances shown on the drawings to be provided with a “Wire Guard” (WG) shall include the model STI-1223 protective cover each with two (2) STI-3100 conduit spacers. The Electrical Contractor shall provide all mounting hardware for these devices.

2.15 FIRE ALARM COMMUNICATOR

A. The fire communicator shall be Underwriters Laboratories, Inc. 864 listed meeting the requirements set forth by NFPA Standard 72. It shall provide two telephone line capability, each with its own line fault monitor and line seizure relay.

   1. It shall be capable of transmitting either touch tone or dial pulse selectable for each line. If a fault is found when communicating with its first preprogrammed telephone number, the unit shall automatically dial a backup number ensuring notification.

B. The Digital Communicator shall be a Siemens 5129 with a TIK5128 telephone interface and a TRI-60 interface module that shall be used for the Fire Alarm System to monitor the Digital Communicator for faults.

2.16 AUXILIARY DEVICES

A. Sprinkler Waterflow and Valve Monitoring Switches: The sprinkler system alarm and monitoring switches shall be provided and installed by others, wired by this contractor.
2.17 MAGNETIC DOOR HOLDERS

A. General: Provide where shown on Drawings Siemens type DH Series electro-magnetic door holders. The holders shall operate with the fire alarm control panel to automatically release the doors when fire or smoke is detected by the system. Provide the appropriate addressable detector base or addressable interface module with relay to release each door. Current draw shall be 0.02 mA at 24 volts with dual voltage inputs. Transient protection shall be integral to unit. Magnetic door holders shall be arranged for wall or floor mounting as indicated and complete with matching door plate.

B. Material and Finish: Match door hardware.

2.18 FIRE ALARM WIRE AND CABLE

A. Fire Alarm Power Branch Circuits: Building wire as specified in Section 28 0523.

B. Initiating, Signal Circuits, Data and 24 VDC Power Cables: Building wire as specified in Section 26 0519. Non-power limited fire-protective signaling cable, copper conductor, 150 volt insulation rated 60 degree C; power limited fire-protective signaling cable, copper conductor, 300 volts insulation rated 105 degree C.

1. Each conductor shall be identified as shown on the drawings at each with wire markers at every splice and terminal point. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.

2. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.

3. Wiring for the analog loop circuits and the network data circuits shall be 18 AWG twisted and shielded FPL type, West Penn Wire No. 975.

4. Wiring for strobe, horn/strobe, audible bases and remote annunciator power circuits shall be a 14 AWG type FPL, West Penn Wire No. 994. (Horns and strobes shall not be installed on the same circuit.)

5. All splices shall be made using solderless connectors. All connectors shall be installed in conformance with the manufacturer's recommendations.

6. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

7. A consistent color code for fire alarm system conductors throughout the installation.

8. Provide Fire Alarm MC Cable, FPLP type (fully plenum rated), with galvanized interlocking steel strip (red-striped), solid copper conductors, THHN conductor insulation, AFC Cable Systems or approved equivalent.

C. The contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.

D. Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.
3.1 INSTALLATION, GENERAL

A. Provide an electrically supervised device addressable Fire Alarm System with remote annunciation as covered by these Specifications, to be wired, connected, and left in first class operating condition. All equipment shall be listed by the Underwriter's Laboratories and shall conform with the requirements of the Pennsylvania Fire Code.

B. Provide in accordance with the manufacturer's instructions, all wiring, conduit, raceways, outlet boxes, and auxiliary equipment required for the installation of the system.

C. Install system in accordance with NFPA Standards referenced in Parts 1 and 2 of this Section.

3.2 EQUIPMENT INSTALLATION

A. Existing Fire Alarm Equipment: Maintain fully operational until the new equipment has been tested and accepted. As new equipment is installed, labeled it "NOT IN SERVICE" until the new equipment is accepted. Remove tags from new equipment when put into service and tag existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of the new fire alarm system, remove existing, disconnected fire alarm equipment and restore damaged surfaces to match adjacent finishes. Package operational fire alarm and detection equipment that has been removed and deliver to the Owner. Remove from the site and legally disposed of the remainder of the existing material.

   1. Install manual pull station with operating handle 42 inches above floor.
   2. Install pull station within 5’ of the entrance to each exit.

D. Water Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.

E. Smoke Detectors: Install detectors indicated to be ceiling mounted not less than 4 inches from a side wall to the near edge. For exposed solid joist construction, mount detectors on the bottoms of the joists. On smooth ceilings, install detectors not over 30 ft. apart in any direction. Install detectors no closer than 5 ft. from air registers.

F. Audible Alarm Indicating Devices: Unless otherwise indicated, install horns on flush mounted back boxes with the device operating mechanism concealed behind a grille.
   1. Install audible notification signal devices, such that measured from the bottom, the device shall be 6” inches below finished ceiling.

G. Visual Alarm Indicating Devices: Install at locations shown on the drawings.
   1. Install visual notification signal devices such that measured from the bottom, the device shall be 80 inches above the floor or 6” below finished ceiling whichever is lower.
3.3 WIRING INSTALLATION

A. The wiring system shall meet the requirements of all applicable national, state, and local electrical codes and shall conform with the requirements of Standard #72 of the National Fire Protection Association.

B. The audible and visual NAC shall be the same.

C. The number of conductors shall be as shown or as required by the equipment manufacturer.

D. Wiring Method: Install wiring in metal raceway provided by the Division 26 Contractor.

E. Wiring within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

F. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where any circuit tap is made.

G. Alarm Wiring: For the low-voltage portion of the fire alarm system, install No. 16 AWG conductors and 75-deg C insulation in wet, damp, or dry locations. Provide wiring operating at line voltage as minimum No. 12 AWG size having similar insulation.

H. Color Coding: Color code all fire alarm conductors differently from the normal building power wiring. Provide one color code for alarm circuits wiring and a different color code for supervisory circuits. Provide a color code for audible alarm indicating circuits different from alarm initiating circuits. Use different colors for visual alarm indicating devices. Paint fire alarm system junction boxes and covers red.

I. Risers: Provide a minimum of two vertical cable risers to serve the fire alarm system. Separate riser runs in close proximity to each other by a fire wall with a minimum one-hour rating so the loss of one riser does not prevent the receipt or transmission of signal from other floors or devices.

J. Final connections between equipment and wiring system shall be made under the direct supervision of a representative of the fire alarm equipment manufacturer.

K. The exact wiring arrangement shall be in accordance with the fire alarm equipment manufacturer's requirements and the exact number of initiating and signalling devices to be furnished and installed shall be as shown on the drawings.

L. Mount end-of-line device box with last device or separate box adjacent to last device in circuit.

M. Make conduit and wiring connections to sprinkler flow switches, sprinkler valve tamper switches, elevator controllers, duct mounted smoke detectors, fans, HVAC starters and to the telephone terminal board.
3.4 PROGRAMMING

A. The Contractor and Manufacturer's Representative shall meet with the Owner and review the requirements for device and location identifications prior to entering any script files. All script files shall be in accordance with the Owner's requirements.

3.5 GROUNDING

A. Ground equipment and conductor and cable shields in accordance with the manufacturer's requirements.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable. The letter shall include the names and titles of the witnesses to the preliminary tests.

D. Final Test Notice: Provide 10 days' minimum notice in writing when the system is ready for final acceptance testing.

1. Minimum System Test: Test the system in accordance with the procedures outlined in NFPA 72, Chapters 4 and 10. Testing specified shall be performed by the installing contractor, the distributor's technician and the building inspector. Minimum required tests are as follows:

2. Verify the absence of unwanted voltages between circuit conductors and ground.

3. Megger test all conductors other than those intentionally and permanently grounded with electronic components disconnected. Test for resistance to ground. Report readings less than 1-megohm for evaluation.

4. Test all conductors for short circuits utilizing an insulation testing device.

5. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.

6. Verify the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.

7. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Proper signal transmission in accordance with class of wiring used shall be observed.
8. Test each initiating and indicating device for alarm operating and proper response at the control unit. Test smoke detectors with actual products of combustion.

9. Test the system for all specified functions in accordance with the manufacturer's operating and maintenance manual. Systematically initiate specified functional performance items at each station including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.

10. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the period and in the manner specified.

E. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

F. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.

1. Provide both a "Certificate of Completion" as outlined in Chapter 4, Section 4.5 of NFPA 72 and the "Inspection and Testing Form" as outlined in Chapter 10 Section 10.6 of NFPA 72. Each shall be fully executed by the manufacturer's representative and the local building inspector.

G. Tag all equipment and stations and other components at which tests have been satisfactorily completed. Place tags upon completion of tests.

3.7 COMMISSIONING

A. Provide the services of a factory-authorized service representative to demonstrate and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 4 hours' training.
2. Schedule training with the Owner at least seven days in advance.
3. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.8 GUARANTEE

A. The contractor shall warrant the entire system against mechanical and electrical defects for a period of one (1) year from the date of final acceptance and as described in the contract general conditions.

1. This period shall begin upon completed certification and test of the system or upon first beneficial use of the system, whichever is earlier.
END OF SECTION 26 1900
SECTION 26 2200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference to transformers specified herein.

C. Requirements of the following Division 26 Sections apply to this section:

1. 26 0100: Basic Electrical Requirements
2. 26 0500: Common Work Results for Electrical
3. 26 0553: Identification for Electrical Systems

1.2 SUMMARY

A. This section includes Dry-type energy efficient transformers per NEMA TP1, with primary and secondary voltages of 600V and less and capacity ratings 15kVA through 750kVA.

1. Distribution transformers

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Product data: Submit manufacturer's technical product data including the following:

1. Rated kVA, frequency, primary and secondary voltages.
2. Number of taps and the corresponding percentages.
3. Percent impedance at 75 degrees C.
4. Certification of transformer performance efficiency at half and full loads.
5. Percentage regulation at 100% and 80% power factor.
6. No-load and full-load losses in watts.
7. Hot-spot and average temperature rise above 40 degrees C ambient temperature.
8. Sound level in decibels.

C. Shop Drawings: Submit manufacturer's drawings indicating dimensions and weight loadings for transformer installations, showing layouts, mountings and supports, spatial relationship to panelboards and associated equipment, include transformer connections to electrical equipment.

D. Wiring diagrams: Submit wiring protection and control diagrams for power distribution transformers. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.
E. Product certificates, signed by manufacturer of transformers certifying that their products comply with the specified requirements.

F. Product Test Reports: Certified copies of manufacturer's design and routine factory tests required by the referenced standards.

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of power/distribution transformers of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects utilizing electrical power and distribution transformers similar to those required for this project.

C. NEC Compliance: Components and installation comply with NEC as applicable to installation and construction of electrical power/distribution transformers.


E. NEMA Compliance: Comply with requirements of NEMA Std Pub/No's ST 20; "Dry-Type Transformers for General Applications", TR 1 and TR 27.

F. UL Compliance: Comply with applicable requirements of ANSI/UL506; "Safety Standard for Specialty Transformers". Provide power/distribution transformers and components that are UL-listed and labeled.

G. Nationally Recognized Testing Laboratory Compliance (NRTL): Items provided under this section shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

H. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

I. Conform to the requirements of ANSI/NFPA 70.

J. Transformers are to be manufactured and tested in accordance with NEMA ST20.

K. Transformers losses shall conform to NEMA TP1 requirements

L. Transformers losses shall be tested in accord with NEMA TP2 procedures

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cutler Hammer Division; Eaton Corporation
2. Square D Company
3. General Electric Company
4. Siemens Industry

2.2 GENERAL

A. Transformers: Factory assembled and tested air cooled units of types specified, having characteristics and ratings as indicated on the drawings under the "Transformer Schedule". Units shall be designed for 60-Hz service.

B. Cores: Grain oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps. Windings shall be copper unless indicated otherwise on the Transformer Schedule.

D. Internal Coil Connections: Brazed or pressure type.

E. Sound Level:

1. 10 thru 50 KVA: Sound-level ratings not to exceed 45 db as determined in accordance with ANSI/NEMA Standards.
2. 51 thru 150 KVA: Sound level ratings not to exceed 50 db as determined in accordance with ANSI/NEMA Standards.
3. 151 thru 300 KVA: Sound level ratings not to exceed 55 db as determined in accordance with ANSI/NEMA Standards.
4. 301 thru 500 KVA: Sound level ratings not to exceed 60 db as determined in accordance with ANSI/NEMA Standards.

2.3 GENERAL PURPOSE, DRY-TYPE TRANSFORMERS

A. Comply with NEMA Standard ST 20 "Dry-Type Transformers for General Applications."
B. Comply with NEMA TP-1-2002 energy efficiency standards.

C. Windings: 2-winding type. Three phase transformers shall use one coil per phase in primary and secondary.

D. Ratings: Transformers shall be rated for continuous operation at required KVA with natural ventilation. Transformers requiring mechanical ventilation shall not be permitted.

E. Insulation and Temperature Limitations
   1. Limit transformer surface temperature rise to a maximum of 65 degrees C.
   2. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with an ambient temperature of 40 degrees C.

F. Terminals
   1. Provide terminal enclosure with hinged cover, to accommodate primary and secondary coil wiring connections and electrical raceway connectors.
   2. Provide terminal leads with connectors installed.
   3. Provide wiring connectors suitable for copper wiring.

G. Vibration Isolation
   1. 45 KVA and smaller: Provide sound attenuating pads, manufactured by Korfund, 1/4" minimum thickness, to support transformers.
   2. 50 KVA and larger: Provide integrally mounted vibration isolation supports between core and Provide all copper windings.

H. Enclosure: Suitable for location indicated.

I. Insulation Class: for transformers 15 kVA or smaller provide 185 degree C class insulation based on 115 degree C rise; for transformers larger than 15 kVA provide 220 degree C class insulation based on 150 degree C rise.

J. Taps:
   1. Three-phase transformers rated 15 through 500 kVA shall be provided with (6) 2-1/2% taps, two above and four below rated primary voltage.
   2. All single-phase transformers and three phase transformers rate below 15 kVA and above 500 kVA, shall be provided with the manufacturer’s standard tap configuration.

K. Accessories: The following accessory items are required where indicated:
   1. Surge Arresters: Low-voltage type, factory-installed and connected to high-voltage terminals; complying with NEMA Standard LA 1.
   2. Surge Arresters: Low-voltage type, factory-installed and connected to low-voltage terminals; complying with NEMA Standard LA 1.
   3. Wall mounting brackets: Manufacturers standard brackets for transformers sized up to 25 kVA where wall mounting is indicated.
2.4 NEMA TP-1 1996 Energy Star Labeled

A. Where shown on the drawings, provide transformers that are low loss type with minimum efficiencies per NEMA TP-1 when operated at 35% of full load capacity. Transformers shall bear the Energy Star label.

PART 3 - EXECUTION

3.1 INSPECTION

A. The Contractor must examine areas and conditions under which power/distribution transformers and ancillary equipment are to be installed, and notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until satisfactory conditions have been corrected in an acceptable manner.

3.2 INSTALLATION

A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NESC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Transformers shall be installed so as to provide the clearance specified by the manufacturer. Transformers 25KVA and larger shall be installed with a minimum of 6” clearance on all four sides for ventilation purposes.

Exceptions:

1. If the manufacturers nameplate requires a larger clearance the Contractor shall comply with the larger requirement.

C. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

D. Install units on vibration mounts as shown; comply with manufacturer's indicated installation method, if any.

E. Connect transformer units to electrical wiring system; comply with requirements of other Division-26 sections.

F. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening valves for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B.

G. Identify transformers in accordance with Division 260553 Section.
3.3 TRANSFORMER BASES

A. Provide a 6" concrete pad for each floor mounted transformer as follows:

1. Coordinate size of transformer pad with actual unit sizes provided. Construct base 4-inches larger in both directions than the overall dimensions of the supported unit.
2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad, 1" at a 45 degree angle.
3. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
4. Place concrete and allow to cure before installation of units. Use Portland Cement conforming to ASTM C 150, 3,000 psi compressive strength, and normal weight aggregate.

3.4 GROUNDING

A. Ground transformers and tighten connections to comply with tightening torques specified in UL Standard 486A.

3.5 FIELD QUALITY CONTROL

A. Prior to energization of transformers, check all accessible connections for compliance with manufacturer's torque tightening specifications.

B. Prior to energization, check circuitry for electrical continuity and for short-circuits.

C. Upon completion of installation of transformers, energize primary circuitry at rated voltage and frequency from normal power source, and test transformers, including but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units or components, and proceed with retesting.

3.6 TESTING


1. Independent Testing Organization: Arrange and pay for the services of an independent electrical testing organization in accordance with the requirements of Division 1 Section "Quality Control Services" to perform tests on transformers.
2. Test Objectives: To assure transformer installation is operational within industry and manufacturer's tolerances, is installed in accordance with Contract Documents, and is suitable for energizing.
3. Procedures: Upon satisfactory completion of tests, attach a label to tested components.
4. Schedule tests and notify Architect at least one week in advance of schedule and of test commencement.
5. Reports: The testing organization shall make a written report of observations and tests. Report defective materials and workmanship and retest corrected defective items.
6. Testing organization shall submit written test reports to the Architect and Contractor.
7. Testing for transformers shall include insulation resistance test, taps verification and excitation test.
8. Test Failures: Correct deficiencies identified by tests and make ready for retest. Verify that equipment meets the specified requirements.

3.7 ADJUSTING AND CLEANING

A. Upon completion of installation, inspect interiors and exteriors of accessible components. Remove paint splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendations within enclosure of each transformer throughout periods during which equipment is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION 26 2200
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SECTION 26 2413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. This section is a part of each Division 26 section making reference to switchboards specified herein.

C. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0100: Basic Electrical Requirements
   2. 26 0500: Common Work Results for Electrical
   3. 26 0553: Identification for Electrical Systems

1.2 DESCRIPTION OF WORK

A. Extent of switchboard work is indicated by drawings and schedules. Provide service entrance cable.

B. Type of switchboard specified in this section include the following:
   1. Dead-Front Distribution.
   2. Owner digital metering.
   3. Provisions for bus extensions to allow for future additional sections.
   4. Main circuit breaker.
   5. Feeder circuit breakers.
   6. Integral transient voltage surge suppression.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E. Firm with at least 5 years of successful installation experience on projects utilizing switchboards similar to those required for this project.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
D. Manufacturers: Firms regularly engaged in manufacture of switchboards, of types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

E. NEC Compliance: Comply with NEC as applicable to wiring methods, construction, and installation of switchboards.

F. UL Compliance: Comply with applicable requirements of Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors", and Standard 891, "Dead-Front Electrical Switchboards", pertaining to installation of switchboards. Provide switchboards and components that are UL-listed and labeled.


H. ANSI Compliance: Comply with applicable requirements of ANSI standards pertaining to switchboard assemblies.


J. Comply with NFPA 70.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and to prevent condensation.

C. Handle and prepare switchboards for installation according to NECA 400 and NEMA PB 2.1.

1.5 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
1.6 SUBMITTALS

A. Product Data: Submit manufacturer's data on switchboards including, but not limited to, voltages, number of phases, frequencies, and short-circuit and continuous current ratings. Provide application data for main and branch circuit-breakers, sections, main buses, and basic insulation levels.

B. Shop Drawings: Submit layout drawings of switchboards showing accurately scaled basic equipment sections including auxiliary compartments, section components, and combination sections.

C. Wiring Diagrams: Submit wiring diagrams for switchboards showing connections to electrical power feeders and distribution branches. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.

PART 2- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide switchboards of the following manufacturer:

1. Eaton Electrical/Cutler-Hammer
2. Square D Company
3. General Electric Company
4. Siemens Industry

B. General: This specification covers indoor 480Y/277V switchboard complete from the incoming line terminals to the outgoing line terminals.

C. Units shall be painted ANSI 61 for indoor service.

D. Indoor Enclosures: Steel, NEMA 250, Type 1.

E. The switchboard shall be designed, assembled, and tested in accordance with latest applicable standards of NEMA, IEEE, and ANSI.

2.2 SWITCHBOARD

A. General Construction: Furnish and install where indicated a dead front type, front and side accessible, completely metal enclosed, self-supporting structure independent of wall supports. Voltage rating shall be as indicated on the drawings. It shall consist of the required number of vertical sections bolted together to form one rigid switchboard 90" high. The sides and rear shall be covered with removable screw-on plates. All edges of front covers or hinged front panels shall be formed.

B. The switchboard bus short circuit shall as indicated on the drawings.
C. Equipment shall comply with the latest applicable standards of NEMA, ANSI and U.L.

D. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips.

E. Switchboard shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.

F. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and finished with gray enamel over a rust-inhibiting phosphatized coating. Color shall be ANSI 61 gray.

G. Bus Bars:
   1. Phase, neutral, and ground busses shall be hard drawn copper of 98 percent conductivity.
   2. Phase bus bars: Provide with ratings as shown on drawings.
   3. Neutral Bus Bar: Provide with the same rating as the phase bus bars. Bond to grounding electrode.
   4. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. A ground bus and lugs shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. Bond to grounding electrode.
   5. All bus work shall be rated to withstand maximum short-circuit stresses.
   6. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane.

H. Main, Neutral, and Ground Lugs:
   1. All lugs shall be compression type suitable for copper cable of sizes indicated on the drawings.

I. All hardware used on conductors shall be high-tensile strength and zinc plated. All terminals shall be of the anti-turn solderless type suitable for copper cable of sizes indicated.

J. All vertical sections shall align front and rear with uniform depth as shown on the drawings. Switchboard bus shall be fully rated in all vertical sections. Tapered bus is not acceptable. Switchboard shall include all necessary hardware to add future breakers in any spaces shown on drawings.

K. All internal devices, except the main disconnect, shall be removable from the front and shall be panel mounted with the necessary line and load connections front accessible. The main device and its connections shall be front accessible.

L. Customer Metering: Provide a separate customer metering compartment with front hinged door and include the following:
   1. 3 - Current transformers ampacity to match that of the main device.
   2. 3 - Potential transformers.
   3. 1 - Digital meter.

M. Main Circuit Breakers:
1. Protective devices shall be fixed insulated case circuit breakers. Frame ratings shall be 2500, 3000, 4000 or 5000 (fixed only) amperes. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

2. Breakers shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawings. The breaker control faceplate shall include color-coded visual indicators to indicate contact OPEN and CLOSED positions as well as mechanism CHARGED and DISCHARGED positions. Manual control pushbuttons on the breakers face shall be provided for “opening” and “closing” the breaker.

3. Electrically operated breakers shall be complete with OPEN/CLOSE pushbuttons on the breaker face plus red and green indicating lights to indicate breaker contact position.

4. Insulated case circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes RMS at rated voltage or as indicated on the drawings.

5. A selective override circuit shall be provided on breakers having short-time adjustments but without instantaneous adjustments that will allow selectively up to its RMS symmetrical short-time rating. This selective override circuit shall allow the breaker to ride through a fully offset (asymmetrical) fault equal to its RMS symmetrical short-time rating in a system having an X/R ratio of 6.6 with a maximum single-phase peak current of 2.3 times the RMS symmetrical short-time ranging. No deviations from this specification shall be acceptable.

6. All breakers shall be provided with a true, two-step stored energy mechanism providing a maximum of five-cycle closing. All the energy required for closing the breakers shall be completely stored and held in readiness pending a release to close action. Manually operated breakers shall be convertible to electrical operation by insertion of an internally mounted motor operator without voiding UL label. Both manually and electrically operated breakers shall have multiple charge/close provisions providing the following possible sequence:

   a. Charge-close-recharge-open-close-open. As a safety feature, provisions shall be available to manually discharge the stored energy without closing the breakers. Anti-pump provisions shall be provided as standard for electrically operated breakers and optional for manual breakers with spring release solenoids.

7. The insulated case breakers shall have high-endurance characteristics being capable of no load and full-load interruptions at rated current equal to or exceeding the UL endurance ratings for molded case breakers without maintenance.

8. Main insulated case breakers shall be provided with Digitrip RMS510 trip units.

9. Main circuit breaker shall be provided with loss of phase protection relay and automatic tripping of main under loss of phase condition.

10. Main circuit breaker shall be furnished with zero sequence ground fault protection systems for use with electric trip. Provide adjustable ground fault current pick up and ground fault time settings with ground fault trip test panel. Set Ground fault at maximum.

N. Feeder Circuit Breakers - 1200A and below:

1. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping.

2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of DE-ION
arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

3. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.

4. Circuit breakers 800 ampere frame and below shall have thermal-magnetic trip units and inverse time-current characteristics.

5. Circuit breakers 800 ampere through 1200-ampere frame shall be Cutler-Hammer Series C with microprocessor-based RMS sensing trip units.

6. Ground fault protection shall be provided where indicated.

7. Where indicated circuit breakers shall be current limiting.

8. Where indicated provide UL listed circuit breakers for applications at 100% of their continuous ampere rating in their intended enclosure.

O. Feeder Circuit Breakers - above 1200A:

1. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping.

2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

3. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.

4. Circuit breakers 1600-ampere through 2500-ampere frame shall have microprocessor-based RMS sensing trip units.

5. Ground fault protection shall be provided where indicated.

6. Where indicated circuit breakers shall be UL listed for series application.

7. Where indicated circuit breakers shall be current limiting.

8. Where indicated provide UL listed circuit breakers for applications at 100% of their continuous ampere rating in their intended enclosure.

P. Transient Voltage Surge Suppressor – Refer To Section 264313

1. Provide integral TVSS protection for switchboard. Refer to Section 264313 for TVSS requirements.

PART 3 - EXECUTION

3.1 INSPECTION

A. Installer must examine areas and conditions under which switchboards and components are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
3.2 SWITCHBOARD BASE

A. Provide a 6" concrete pad for the switchboard as follows:

1. Coordinate size of switchboard pad with actual unit sizes provided. Construct base 4-inches larger in both directions than the overall dimensions of the supported unit.
2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad, 1" at a 45 degree angle.
3. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
4. Place concrete and allow to cure before installation of units. Use Portland Cement conforming to ASTM C 150, 3,000 psi compressive strength, and normal weight aggregate.

3.3 INSTALLATION

A. Install switchboards as indicated, in accordance with manufacturer's written instructions, with recognized industry practices; complying with applicable requirements of NEC, NEMA's Standard PB 2.1, and NECA's "Standard of Installation".

B. Coordinate with other work including electrical cabling/wiring work, as necessary to interface installation of switchboards with other work.

C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A.

3.4 LABELING

A. Provide an engraved switchboard label centered on the top front of the switchboard. The label shall be formatted as follows:

```
MAIN SWITCHBOARD
VOLTAGE/NUMBER OF PHASES/NUMBER OF WIRES
```

B. Provide an engraved label for each breaker in the switchboard including the main and spares. Each label be formatted as follows:

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IDENTIFICATION OF LOAD BY EQUIPMENT TAG
CURRENT RATING/NUMBER OF POLES
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3.5 ADJUSTING AND CLEANING

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finish.
3.6 GROUNDING

A. Provide equipment grounding connections for switchboards as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

3.7 FIELD QUALITY CONTROL

A. Prior to energization of circuitry, check all accessible connections to manufacturer's tightening torque specifications.

B. Prior to energization of switchboard, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

C. Prior to energization, check switchboards for electrical continuity of circuits, and for short-circuits.

D. Subsequent to wire and cable hook-ups, energize switchboard and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

E. Testing Agency: Engage a qualified independent testing agency to perform specified testing.

F. Testing: After installing switchboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.6 for all circuit breakers 200 amps and larger. Certify compliance with test parameters.
SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference to panelboards specified herein.

C. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0100: Basic Electrical Requirements
   2. 26 0500: Common Work Results for Electrical
   3. 26 0553: Identification for Electrical Systems

1.2 SUMMARY

A. This Section includes loadcenters and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:
   1. Lighting and appliance branch-circuit panelboards.
   2. Circuit breaker distribution panelboards.

1.3 DEFINITIONS

A. Load Center: A panelboard with thermal magnetic circuit-breaker branches, primarily of the plug-in type, designed for residential and light commercial projects, operating at 240 V and below, available in both single and 3-phase versions, and equipped with combination flush/surface mounting trim.

B. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. RFI: Radio-frequency interference.

F. SVR: Suppressed voltage rating.
1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

2. Shop Drawings: For each panelboard, including the following:
   a. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following data:
      1) Enclosure types and details for types other than NEMA 250, Type 1.
      2) Bus configuration, and current, and voltage ratings.
      3) Short-circuit current rating of panelboards and overcurrent protective devices.
      4) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.

3. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

4. Qualification Data: Submit data for testing agencies indicating that they comply with qualifications specified in “Quality Assurance” Article.

5. Field Test Reports: Submit written test reports and include the following:
   a. Test procedures used.
   b. Test results that comply with requirements.
   c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.


7. Maintenance Data: For panelboards and components to include in Operating and Maintenance Manual specified in Division 01 and in Division 26 Section COMMON WORK RESULTS FOR ELECTRICAL. In addition to requirements specified in Division 01 and 26, include the following:
   a. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.
   b. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
B. Manufacturers: Firms regularly engaged in manufacture of panelboards and enclosures, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

   1. All equipment shall be fabricated and assembled at the manufacturer’s plant. Equipment assembled by OEM or another assembly will not be accepted.

C. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with utilizing panelboards similar to those required for this project.

D. NEC Compliance: Comply with NEC as applicable to installation of panelboards, cabinets, and cut-out boxes.

E. UL Compliance: Comply with applicable requirements of Std No. 61 "Panelboards", and Stds No.'s 50, 67, 98, 248, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories and enclosures. Provide units which are UL-listed and labeled.

F. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)", Pub/No. PB1, "Panelboards", and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less".


1.6 COORDINATION

   A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.7 EXTRA MATERIALS

   A. Keys: Furnish six spares of each type for panelboard cabinet locks.

   B. Touch-up Paint: For surface-mounted panelboards - one half-pint container.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

   A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   B. Manufacturers: Subject to compliance with requirements, provide products by the following:

      1. Panelboards, Overcurrent Protective Devices, Contactors, and Accessories:
a. Square D Company  
b. Eaton Corp.; Cutler-Hammer Products  
c. Siemens Industry  
d. General Electric Company

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush and surface mounted cabinets as indicated on the drawings. NEMA PB 1, Type 1 enclosure (6” deep and 20” wide) to meet environmental conditions at installed location.  
   1. Outdoor Locations: NEMA 250, Type 3R

B. Door in Door Front: Entire front trim hinged to box with standard door within hinged trim cover (EZ Trim not acceptable).

C. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

D. Directory Card: Mounted inside metal frame, inside panelboard door with 1/16” minimum transparent protective cover.

E. Bus: All phase, neutral and ground busses shall be hard-drawn copper, 98 percent conductivity.
   1. Phase bus bars: Provide with rating as shown on drawings.  
   2. Neutral bus bar: Provide with same rating as the phase bus bars.  
   3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. A ground bus and lugs shall be furnished firmly secured to the enclosure (each section/tub). Bond to enclosure.  
   4. All bus work shall be rated to withstand short-circuit stresses at specified voltage as described on the panelboard schedules shown on the drawings.

F. Main and Neutral Lugs: All lugs shall be set screw solderless type suitable for use with copper conductor material of sizes indicated on the drawings.

G. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches (maximum of 6).

H. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the OCPD ampere ratings indicated for future installation of devices.

I. Feed-through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

J. Subfeed: Overcurrent protective device or lug provision as indicated on the drawings.

2.3 PANELBOARD SHORT - CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

B. Minimum Integrated Short Circuit rating shall be 22,000 amperes RMS symmetrical at the specified voltage, unless otherwise specified on the panelboard schedules shown on the drawings. The short circuit rating of the assembled panelboards shall be test verified and UL
listed. This rating shall be the lowest interrupting rated device in the panelboard. Panelboards with a "SERIES SHORT CIRCUIT RATING" are not acceptable.

2.4 LOAD CENTERS
   A. Shall comply with UL 67.
   B. Overcurrent Protective Devices: Plug-in, full-module circuit breaker, replaceable without disturbing adjacent units.
   C. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
   A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for those applications indicated.
   B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
   C. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 DISTRIBUTION PANELBOARDS
   A. Doors: Front mounted, except omit in fused-switch panelboards; secured with vault-type latch with tumbler lock; keyed alike.
   B. Main Overcurrent Protective Devices: Circuit breaker.
   C. Branch overcurrent protective devices shall be one of the following:
      1. For Circuit-Breaker Frame Sizes 125 amp and smaller: Bolt-on circuit breakers.
      2. For Circuit-Breaker Frame Sizes Larger Than 125 amp: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.7 TRANSIENT VOLTAGE SUPPRESSION PANELBOARDS
   A. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   B. Main Overcurrent Devices: Thermal-magnetic circuit breaker.
C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.

D. Bus: Copper phase and neutral buses.


1. Minimum Single-Impulse Current Ratings:
   a. Line to Neutral: 100,000 A.
   b. Line to Ground: 100,000 A.
   c. Neutral to Ground: 50,000 A.

2. Protection modes shall be as follows:
   a. Line to neutral.
   b. Line to ground.
   c. Neutral to ground.

3. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.

4. Maximum Category C Combination Wave Clamping Voltage: 600V, line to neutral and line to ground on 120/208V.

5. Maximum UL 1449 Clamping Levels: 400V, line to neutral and line to ground on 120/208V.

6. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.

7. Accessories:
   a. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
   b. Audible alarm activated on failure of any surge diversion module.
   c. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

2.8 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.


   a. Circuit breakers shall have quick-make, quick-break operating mechanisms and silver alloy contacts.
   b. Circuit breakers shall have a common trip bar for all poles. The operating handle shall indicate ON, TRIPPED, and OFF positions.
   c. Circuit breakers shall be electrically and mechanically trip free.
d. Circuit breakers and terminals shall have a UL 60/75 degree celsius rating.

2. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.
4. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I²t response.

B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment, Type HID for connection to high intensity discharge (HID) lighting loads to handle ballast in-rush current.
3. Branch circuit breakers shall be rated 20 amps or larger where so indicated; and shall have bolted line connections arranged and assembled as indicated on drawings. Provide a full complement of active and spare breakers, except where "space" or "provision" is noted.
4. Provide handle interference devices (lockdogs) on circuit breakers serving emergency load, and on other breakers as scheduled.
5. Tandem circuit breakers shall not be used.
6. Multi-pole breakers shall have common trip.
8. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

2.9 CONTROLLERS

A. Contactors: NEMA ICS 2, Class A combination controller equipped for panelboard mounting and including the following accessories:

1. Individual control-power transformers.
2. Fuses for control-power transformers.
3. Indicating lights.
4. Seal-in contact.
5. Two convertible auxiliary contacts.
7. Selector switches.

B. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install panelboards and accessory items in accordance with NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or less" and manufacturers' written installation instructions.

B. Install flush mounted panelboards with an overlapping trim set tight to the wall surface.

C. Provide a full complement of circuit breakers in each panelboard, except where "space" or "provision" is noted.

D. Coordinate installation of panelboards and enclosures with cable and raceway installation work.

E. Mounting Heights: Top of trim 74 inches (1880mm) above finished floor, unless otherwise indicated.

F. Mounting: Plumb and rigid without distortion of box. Mount flush panels uniformly flush with wall finish.

G. Panelboard Directory

1. All panelboard directories shall reflect the as built electrical configuration of the job, including the approved changes required to balance the panel loads.
2. Each directory entry shall include a description of the connected load(s) and the room number, which corresponds to the location(s) of the connected loads.
3. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

H. Install filler plates in unused spaces.

I. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panel into accessible ceiling space or space designated to be ceiling space in the future.

J. Wiring in Panel Gutters: Arrange conductors neatly in groups and bundle and wrap with wire ties after completion of load balancing.

K. Auxiliary Gutter: Install where a panel is tapped to a riser at an intermediate location.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals, including grounding connections, in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit and test for short-circuits.

B. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.

C. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.

D. Check panelboard mounting, area clearances and alignment and fit of components.

E. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.

F. Testing Agency: Engage a qualified independent testing agency to perform specified testing.

G. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

   1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.6 for circuit breakers 200 amps and larger. Certify compliance with test parameters.

H. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:

   1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING
   A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING
   A. Upon completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.7 DISTRIBUTION PANELBOARD BASE
   A. Provide a 6” concrete pad for the panelboard as follows:
      1. Coordinate size of panelboard pad with actual unit sizes provided. Construct base 4” larger in both directions than the overall dimensions of the supported unit.
      2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad, 1” at a 45 degree angle.
      3. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
      4. Place concrete and allow to cure before installation of units. Use Portland Cement conforming to ASTM C 150, 3,000 psi compressive strength, normal weight aggregate.

3.8 LABELING OF CIRCUIT BREAKER DISTRIBUTION PANELBOARDS
   A. Provide an engraved panelboard label centered on the top front of the panelboard. The label shall be formatted as follows:

   MAIN CIRCUIT BREAKER PANELBOARD
   VOLTAGE/NUMBER OF PHASES/NUMBER OF WIRES

   B. Provide an engraved label for each breaker in the panelboard including the main and spares. Each label shall be formatted as follows:

   IDENTIFICATION OF LOAD BY EQUIPMENT TAG
   CURRENT RATING/NUMBER OF POLES

END OF SECTION 26 2416
SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference to identification specified herein.

C. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0100: Basic Electrical Requirements
   2. 26 0500: Common Work Results for Electrical
   3. 26 0529: Hangers and Supports for Electrical Systems
   4. 26 0533: Raceway and Boxes for Electrical Systems
   5. 26 0553: Identification of Electrical Systems

1.2 SUMMARY

A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems that are intended to carry, but not utilize, electric energy.

B. This Section includes the following:
   1. Single and duplex receptacles, ground-fault circuit interrupters, and integral surge suppression units.
   2. Single-pole, three-way and four-way snap switches.
   3. Device wall plates.
   4. Floor service outlets, poke-through assemblies, and multi-outlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. PVC: Polyvinyl chloride.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.
1.4 SUBMITTALS

A. Product data: Submit manufacturer's data for each type of product specified.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical wiring devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firms with at least 2 years of successful installation experience on projects utilizing wiring devices similar to those required for this project.

C. NEC Compliance: Comply with NEC as applicable to installation and wiring of electrical wiring devices.

D. UL Compliance: Comply with applicable requirements of UL20, 486A, 498, and 943 pertaining to installation of wiring devices. Provide wiring devices that are UL listed and labeled.


F. NEMA Compliance: Comply with applicable portions of NEMA Standards Pub/No. WD 1, "General-Purpose Wiring Devices", and WD5, "Specific-Purpose Wiring Devices".

G. FS Compliance: Comply with FS W-C-596 (Series) and FS W-S-896 (Series) pertaining to electrical power connectors and toggle switches.

H. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

I. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

J. NFPA Compliance: Comply with applicable portions for NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Service Outlet Assemblies: One for every 10, but no fewer than one.
2. Poke-Through, Fire-Rated Closure Plugs: One for every 10 floor service outlets installed, but no fewer than one.
3. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide wiring devices of one of the following (for each type and rating of wiring device):

1. Hubbell Inc.
2. Cooper Wiring Devices
3. Pass & Seymour
4. Leviton

2.2 FABRICATED WIRING DEVICES

A. General: Provide factory-fabricated wiring devices, in types, colors and electrical ratings for applications indicated and that comply with NEMA Standards Pub/No. WD 1.

2.3 RECEPTACLES

A. General Receptacles

1. Provide heavy duty type NEMA 5-20R, back and side wired, with green ground screw terminal, automatic ground clamp, fully enclosed in composition case, nylon face, and having wrap around bridge for installation strength. Comply with NEMA WD1, NEMA WD6, DSCC W-C-596G and UL 498.
2. Receptacles shall be ivory in color, or as otherwise indicated on Drawings, or as directed by Architect. Devices installed in surface raceways shall match the raceway color. The Contractor shall verify color selections with the Architect and Owner prior to ordering any devices.

a. Exception:

1) Provide gray duplex receptacles for all receptacles identified on the drawings with a PC subscript notation.
3. Provide one of the following for Single:
   a. Hubbell Type HBL5351
   b. Cooper Type 5351
   c. Pass & Seymour Type 5381
   d. Leviton Type 5891

4. Provide one of the following for Duplex:
   a. Hubbell Type CR5352
   b. Cooper Type 5352
   c. Pass & Seymour Type 5352
   d. Leviton Type 5352

B. Hospital Grade Receptacles

1. Provide heavy duty HOSPITAL GRADE type NEMA 5-20R, back and side wired, with green ground screw terminal, automatic ground clamp, fully enclosed in composition case, nylon face, and having wrap around bridge for installation strength.
2. Receptacles shall be ivory in color, or as otherwise indicated on Drawings, or as directed by Architect. The Contractor shall verify color selections with the Architect and Owner prior to ordering any devices.
   a. Exception:
      1) Provide Red duplex receptacles for all receptacles identified on the drawings as being connected to a normal-emergency power circuit.

3. Provide one of the following for Single:
   a. Hubbell Type HBL8310
   b. Pass & Seymour Type 9301-HG
   c. Leviton Type 8310

4. Provide one of the following for Duplex:
   a. Hubbell Type HBL8300H
   b. Pass & Seymour Type 9300-HG
   c. Leviton Type 8300

C. Ground Fault Current Interrupter Receptacles

1. Ground fault circuit interrupters shall be receptacle-type devices with screw terminals or with pigtails, 20 amps 120 volt NEMA 5-20R, UL class A. Interrupters shall be UL listed in accordance with UL 498, UL 943, NEMA WD 1, NEMA WD6.
2. Include indicator light that is lighted when the device is tripped.
3. Units shall be designed for installation in a 2-3/4 inch deep outlet box without an adapter.
4. Where more than one ground fault circuit interrupter type receptacle is shown in the same area and on the same branch circuit, the Contractor shall install a GFIC with feed-through capability, first in the circuit, so general type receptacles may be used down stream to
continue providing ground fault protection. The Contractor shall tag the general type receptacles to identify them as being ground fault protected.

5. Provide one of the following:
   a. Hubbell Type GFR5352
   b. Cooper Type VGF20
   c. Pass & Seymour Type 2095-L
   d. Leviton Type 8898

D. Surge Suppression Receptacles

1. Shall have visual and audible surge status indicators to alert user to surge suppression circuit condition. Visual indicator will be illuminated (red) when power is on and surge suppression circuit is fully functional. Visual indicator will not be illuminated when power is off, or surge suppression circuit has been damaged. Audible indicator will be silent when surge suppression circuit is fully functional. Audible indicator will sound an alarm ("beep") approximately every thirty seconds if surge suppression circuit has been damaged.

2. Straight blade, NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, with integral TVSS in line to ground, line to neutral, and neutral to ground.

3. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J line to neutral, and 70 J line to ground and neutral to ground, and minimum 15000 amperes peak current. According to IEEE C62.41.2 and IEEE C62.45.

4. A line voltage rated fuse specially calibrated to disconnect the surge suppression circuit in the event of catastrophic failure shall be used.

5. Provide heavy duty receptacle with isolated ground terminal rated 20 ampere 125 volts.

6. Receptacles shall be blue in color, or as otherwise indicated on Drawings, or as directed by Architect. The Contractor shall verify color selections with the Architect and Owner prior to ordering any devices.

7. Provide one of the following:
   a. Hubbell Type HBL5362SA
   b. Cooper Type 5362-S
   c. Pass Seymour Type 8300BLSP
   d. Leviton Type 8380

2.4 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration shall be described on drawings, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper
   b. Hubbell
   c. Leviton
   d. Pass & Seymour
B. Pendant Cord/Connector Devices

1. Description: Matching, locking-type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, heavy-duty grade.

   b. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

C. Cord And Plug Sets

1. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

   a. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2.5 SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper; 2221 (single pole), 2223 (three way), 2224 (four way).
   b. Hubbell; CS1221 (single pole), CS1223 (three way), CS1224 (four way).
   c. Leviton; 1221-2 (single pole), 1223-2 (three way), 1224-2 (four way).
   d. Pass & Seymour; 20AC1 (single pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper; 2221PL for 120 V and 277 V.
   b. Hubbell; HPL1221PL for 120 V and 277 V.
   c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
   d. Pass & Seymour; PS20AC1-PLR for 120 V.

3. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
D. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

   b. Hubbell; HBL1557.
   c. Leviton; 1257.
   d. Pass & Seymour; 1251.

2.6 WIRING DEVICE ACCESSORIES

A. Wall plates: single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide .04 inch thick, Type 302 brushed stainless steel flush cover plates.

1. Exceptions:

   a. Blank cover plates shall match adjacent device plates.
   b. Weatherproof cover shall be gasketed cast metal and rated for in-use protection, equal to Intermatic WP1010HMC with locking cover.
   c. Surface cover plates shall be raised galvanized steel with rounded corners for surface mounted outlet boxes and junction boxes in unfinished areas.

B. Provide wall plates with engraved legend where indicated. Conform to requirements of Section ELECTRICAL IDENTIFICATION.

C. Floor Service Outlets: modular, above-floor service outlets and fittings of types and ratings indicated. Construct of die cast aluminum, satin finish. Use design compatible with floor outlet wiring methods indicated. Provide 20-amperes, 125-volts, gray duplex receptacles. NEMA configuration 5-20R where indicated. Provide with 3/4 inch or 1 inch NPT, 1 inch long, locking nipple for installation where compatible with wiring method. Provide voice and data jacks as shown on the drawings.

1. Manufacturers: Subject to compliance with requirements, provide by one of the following:

   a. Wiremold
   b. Hubbell
   c. Pass & Seymour
   d. Thomas and Betts

D. Poke-Through Assembly Devices: factory-fabricated poke-through assembly devices with modular, above-floor service outlets, multi-channeled thru-floor raceway/fire stop assembly and below-floor junction box assembly. Construct above floor service fitting of die cast, satin finished aluminum with 20-ampere, 125-volts, gray duplex NEMA 5-20R receptacle and modular communication/data service outlet with separation barrier between power and low-tension section. Provide integral assembly UL listed as a total unit, with fire rating consistent with that of floor penetrated. Provide voice and data jacks as shown on the drawings.
1. Manufacturers: Subject to compliance with requirements, provide by one of the following:
   a. Wiremold
   b. Hubbell
   c. Pass & Seymour
   d. Thomas and Betts

PART 3- EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtailed.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Common Work Results for Electrical."
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 PROTECTION

A. Protect installed components from damage. Replace damaged items prior to final acceptance.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems".

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Cables".

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 2726
SECTION 26 2813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference to fuses specified herein.

C. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0100: Basic Electrical Requirements
   2. 26 0500: Common Work Results for Electrical

1.2 SUMMARY

A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, controllers, and motor-control centers; and spare fuse cabinets.

   1. Class L Time-Delay Fuses.
   2. Class RK1 Time-Delay Fuses
   3. Spare Fuse Cabinet.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections:

B. Product Data: Include the following for each fuse type indicated:

   1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   2. Let-through current curves for fuses with current-limiting characteristics.
   3. Time-current curves, coordination charts and tables, and related data.
   4. Fuse size for elevator feeders and elevator disconnect switches.

C. Ambient Temperature Adjustment Information. If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses adjusted.

   1. For each adjusted fuse, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
   2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

D. Maintenance Data: For tripping devices to include in maintenance manuals specified in Division 01.
E. Shop drawing of spare fuse cabinet showing dimensions and features including storage provision for fuse cartons.

1.4 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single manufacturer.

B. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

C. ANSI Compliance: Comply with applicable requirements of ANSI C97 "Low-Voltage Cartridge Fuses 600 Volts or Less".

D. UL Listing and Labeling: Items provided under this Section shall be listed and labeled by UL.

E. Comply with NEMA FU 1.

F. Nationally Recognized Testing Laboratory Listing and Labeling (NRTL): Items provided under this Section shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40°F (4.4°C) or more than 100°F (38°C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver spare fuses stored in locked spare fuse cabinet after cabinet has been installed.

1.8 EXTRA MATERIALS

A. Maintenance stock - fuses: For types and ratings required, furnish spare fuses, amounting to one unit for every 5 installed units, but not less than one set of 3 of each kind.

B. Provide three fuse pullers of varying sizes with the spare fuse cabinet.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Bussmann Division, Cooper Industries, Inc.
2. Shawmut Division; Gould Inc.
3. Littlefuse, Inc.

2.2 FUSES, GENERAL

A. General: Provide fuses of types, classes, and current ratings as indicated. Voltage ratings shall be consistent with the circuits on which used.

2.3 CARTRIDGE FUSES


1. Fuses shall be of the same manufacturer.
2. Class L Fuses: Comply with UL 198C, "High-Interrupting Capacity Fuses, Current-Limiting Type.
3. Class RK1 Dual Element Time Delay Fuses: Comply with UL 198E, "Class R Fuses."

2.4 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 18 gage minimum steel unit with full-length, recessed piano-hinged door with key coded cam lock and pull.

B. Size: Provide for orderly storage of all spare fuses of this project plus 15 percent spare capacity, minimum.

C. Finish: Gray baked enamel.

D. Cabinet Door: Bear the legend in stenciled 1-1/2-inch-high letters, "Spare Fuses."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION OF FUSES

A. Fusible Switches: Apply the following class and types:

1. 30-600 Amperes: Class RK1, time delay.
2. 601-1,200 Amperes, Motor, or Transformer Circuit: Class L, time delay.

B. Combination Starters: Class RK1, time delay.

3.3 INSTALLATION

A. Provide fuses in all fuse gaps of all equipment provided under this Contract.

B. Install fuse so that ratings are readable without removing fuse.

C. Fuses shall not be installed until equipment is ready to be energized.

D. Install spare fuse cabinet wall mounted where indicated.

3.4 FIELD QUALITY CONTROL

A. Prior to energization of fusible devices, test devices for continuity of circuitry and for short-circuits. Replace malfunctioning units with new units, and then demonstrate compliance with requirements.

3.5 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fusible device.

END OF SECTION 26 2813
SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. This section is a part of each Division 26 section making reference to enclosed switches and circuit breakers specified herein.

C. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0100: Basic Electrical Requirements
   2. 26 0500: Common Work Results for Electrical
   3. 26 2813: Fuses

1.2 SUMMARY

A. This Section includes circuit and motor disconnects.

B. Extent of circuit and motor disconnect switch work is indicated by drawings and schedules.

C. Types of circuit and motor disconnect switches in this section include the following:
   1. Equipment disconnects
   2. Appliance disconnects
   3. Motor-circuit disconnects

D. Wires/cables, raceways, and electrical boxes and fittings required in connection with circuit and motor disconnect work are specified in other division 26 sections.

1.3 SUBMITTALS

A. Product Data: For each type of switch, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Maintenance data for circuit and motor disconnects, for inclusion in Operation and Maintenance Manual specified in Division 01 and Division 26 Section 260100.

C. Shop Drawings: Submit shop drawings of electrical circuit and motor disconnect switches showing accurately scaled switches, their layouts, and proximity to associated equipment.
D. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
4. UL listing for series rating of installed devices.
5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

E. Maintenance Data: For enclosed switches and components to include in maintenance manuals specified in Division 01. In addition to requirements specified in Division 01 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for components.
2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
3. Time-current curves, including selectable ranges for each type of circuit breaker.

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of circuit and motor disconnect switches of types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing circuit and motor disconnect work similar to that required for this project.

C. NEC Compliance: Comply with NEC requirements pertaining to construction and installation of electrical circuit and motor disconnect devices.

D. UL Compliance: Comply with requirements of UL98, "Enclosed and Dead-Front Switches". Provide circuit and motor disconnect switches that have been UL-listed and labeled.

E. UL Compliance: Comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials that are UL-listed and labeled.

F. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub No. KS 1, "Enclosed Switches" and 250, "Enclosures for Electrical Equipment (1000 volts maximum).

G. Product Selection for Restricted Space: Drawings indicate the location where enclosed switches are to be installed. Verify the suitability for installation in this location, including clearances between enclosures, and adjacent surfaces and other items.
PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide circuit and motor disconnects of one of the following:

1. Square D Company
2. Cutler-Hammer Inc.
3. General Electric Company
4. Siemens

2.2 FABRICATED SWITCHES

A. Heavy Duty Safety Switches: Provide surface-mounted, heavy-duty type, sheet-steel enclosed safety switches of types, sizes and electrical characteristics indicated on the drawings.

B. Provide switches with quick-make, quick-break type operation, with switchblades that are visible in the 'OFF' position with door open.

C. Operating handle shall be an integral part of the enclosure base the operating position shall be easily recognizable and pad-lockable in OFF position.

D. Current carrying parts shall be constructed of 98% conductivity copper, with silver-tungsten type switch contacts and positive pressure type reinforced fuse clips.

E. Enclosures shall meet environmental conditions of installed location.

1. Indoor Locations: NEMA 250, Type 1
2. Outdoor Locations: NEMA 250, Type 3R.
4. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

F. Provide motor and motor starter disconnects with horsepower ratings suitable to the loads.

G. Fusible Switches: Heavy duty switches, with positive pressure type reinforced fuse clips and fuses of classes and current ratings indicated. See division 26 section FUSES for specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.

H. Provide disconnect switches having the capability to have auxiliary contacts mounted as required.

I. Disconnects shall be finished in manufacture’s standard gray finish unless otherwise noted on drawings.
PART 3 - EXECUTION

3.1 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS

A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA and NECA's "Standard of Installation" and in accordance with recognized industry practices.

C. Coordinate circuit and motor disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

D. Install disconnect switches for use with motor-driven appliances, and motors and controllers within sight of the controller position unless otherwise indicated.

E. Coordinate layout and installation of switches and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

F. Install power wiring. Install wiring between switches and control, and indication devices.

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.2 NEUTRAL BAR

A. When a neutral conductor is required for the load connected to a safety switch, the Contractor shall provide a copper neutral bar in the safety switch. This copper neutral bar shall be furnished by the manufacturer of the disconnect switch and shall be designed to be installed within the particular disconnect switch installed.

3.3 GROUNDING

A. Install equipment grounding connections for switches with ground continuity to main electrical ground bus.

B. Provide an equipment grounding kit with all disconnect switches.

C. Connections shall be tightened in accordance with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors".
3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed switch, component, and control circuit.
2. Test continuity of each line- and load-side circuit.

B. Testing Agency: The Contractor shall perform the following testing or engage a qualified independent testing agency to perform testing.

C. Testing: After installing enclosed switches and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches 200 amps and larger. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 CLEANING

A. Upon completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 2816
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SECTION 26 3213 - DIESEL ENGINE GENERATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
B. Requirements of the following Division 26 Sections apply to this section:
   1. 260100: Basic Electrical Requirements
   2. 260500: Common Work Results for Electrical

1.2 DESCRIPTION OF WORK
A. Provide a diesel generator set and accessories.
B. Provide a double walled, stand-alone fuel tank.

1.3 SUMMARY
A. Extent of diesel generator set work is indicated by drawings and schedules, and is hereby defined to include, but not by way of limitation, diesel engine, electrical generator, engine starting system including batteries, instrument control panel, exhaust silencer, wall thimble, and accessories.
B. Types of standby generator system equipment required for project include the following:
   1. Diesel engine-driven generator.
C. Concrete and grout for engine-driven generator pads, foundations, frames and bedplates are specified in Division 3 CONCRETE sections and shall be provided by the Electrical Contractor.
D. Vibration control for diesel engine-driven generator units including, pads, springs, rails, bases, hangers, and connectors shall be as recommended by the generator manufacturer for vibration control and isolation.
E. Piping and associated accessories required for installation of diesel fueled engine-driven generator units are specified in Division-23 section pertaining to fuel oil systems.
F. Refer to other Division 26 sections for wires/cables, electrical boxes and fittings, and wiring devices that are required in conjunction with the engine-generator work.
1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data on engine-driven generator sets and components. This shall include the operating characteristic curves showing percent voltage dip versus locked rotor KVA and percent efficiency versus KVA.

B. Provide the manufacturer's standard product warranty, for duration of not less than five years, for replacement of materials and equipment used in generator systems. Warranty shall include all parts and labor.

C. Shop Drawings: Submit layout drawings of engine-driven generator units and accessories including, but not limited to fuel piping, remote start-stop stations, and instrumentation. In addition, show generator set units and their spatial relationship to associated equipment. Allow adequate clearance space for removal of engine generator elements for maintenance purposes.

D. Wiring Diagrams: Submit wiring diagrams for the engine-driven generator units showing connections to electrical power panels, feeders and ancillary equipment. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

E. Agreement to Maintain: Prior to time of final acceptance, the Installer shall submit 4 copies of an agreement for continued service and maintenance of the engine-driven generator sets, for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner.

F. Certifications: Provide engine-driven generator sets certified test record of the following final production testing:

2. Transient and steady-state governing.
3. Safety shutdown device testing.
4. Voltage regulation.
5. Rated power.
6. Maximum power.

G. Provide certified test record prior to engine-driven generator set being shipped from factory to project location.

1.5 WARRANTY

A. The complete standby electric power system (equipped with set exerciser and running time meter) shall be warranted for a period of five (5) years or fifteen hundred operating hours, whichever occurs first, from the date of initial start-up. The warranty must be provided by the system manufacturer. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Warranty shall include all parts and labor.
1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of diesel engine-driven generator units and ancillary equipment, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with diesel engine-driven generator units similar to those required for this project.

1. Agreement to Maintain: Engage Installer who is willing to execute with the Owner, required agreement for continued maintenance of the engine-driven generator sets.

C. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 230, 240, 250, 445, 517, 620, 695, 700, 701, 702, and 705 pertaining to construction and installation of emergency and standby systems.


3. UL Compliance: Comply with applicable requirements of UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors", and UL 2200, "Stationary Generators".

4. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators", and MG 2, "Safety and Use of Electric Motors and Generators".

5. NEMA Compliance: Comply with applicable requirements of NEMA's Standards Pub No. 250, "Enclosures for Electrical Equipment (1000-Volts Maximum)".

6. EPA Compliance: Engine-driven generator shall meet all applicable EPA requirements and shall be certified as meeting all emissions requirements.


1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver the engine-driven generator properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type of containers or wrappings for engine-generator and components that protect equipment from damage.

B. Store the engine-driven generator equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle the engine-driven generator equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.
2.1 ACCEPTABLE MANUFACTURERS

A. The acceptable manufacturers shall be Cummins Power Generation, Kohler Power Systems and Caterpillar and constitute the type and quality of equipment to be furnished. Substitution of alternate manufacturers, other than those indicated, is not acceptable. The emergency generator system shall be complete in every respect including all necessary equipment shown or not shown on the drawings to perform the functions relative to the system operation. All published specifications of the above manufacturers shall be considered as part of this specification even though they may not be shown in complete detail.

B. Diesel Generator Set:

1. General: Except as otherwise indicated, provide manufacturer's standard engine-driven generator set and auxiliary equipment as indicated by published product information, and as required for a complete installation.

C. Diesel Engine-Driven Generator

1. Provide a packaged standby power natural gas engine-driven generator assembly unit as indicated on Single-Line Diagram on drawing E600, at a governed speed of 1800 RPM, and rated 80 percent power factor for continuous operation, 480Y/277-volt, 3-phase, 4-wire, 60 Hz.

2. Provide a diesel-fueled turbocharged, four-cycle (a 2-cycle engine is not acceptable), liquid-cooled engine. Intake and exhaust valves shall be heat-resisting alloy steel, and free rotating. Exhaust valve seat inserts shall be provided. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have coolant and oil filters with replaceable elements; lube oil cooler and a fuel transfer pump. Engine speed shall be governed by an electronic governor to maintain isochronous alternator frequency from no-load to full-load alternator output. The engine shall have a 24 Volt DC battery charging alternator with a transistorized voltage regulator. Remote, 2-Wire starting shall be by a 24 Volt, solenoid shift, and electric starter.

3. Provide unit-mounted blower fan, thermostat, and radiator duct flange capable of cooling engine to a maximum 122 Degrees F ambient temperature.

4. Provide associated control equipment to automatically start engine, transfer load to standby power upon failure of normal power source, transfer load back to normal power upon its restoration, and stop engine.

5. Mount engine-generator on heavy steel base with vibration spring isolators to reduce possibility of torsional vibration. Number of isolators to be determined by the engine-generator supplier.

6. Provide engine with low-oil pressure, and automatic over-speed safety shutdown devices.

7. Provide generator with PMG exciter and voltage regulator to maintain voltage regulator within 0.5 percent of rated value.

8. Starting System: Provide engine-generator unit with 24-volt, 2-wire, negative ground, starting system including, 24-volt positive engagement solenoid shift-starting motor, batteries and 45-ampere, or greater, automatic battery charging alternator with solid-state voltage regulation, and disconnect relay to disconnect battery charger during engine starting and running.
9. Diesel generator shall be seismic certified and be provided with suitable seismic rated spring vibration isolators.

D. Instrument Control Panel:

1. Provide engine-generator control panel with the following:
   a. Voltmeter, 3.5”, 2% accuracy
   b. Ammeter, 3.5”, 2% accuracy
   c. Voltmeter/ammeter phase selector and OFF switch
   d. Engine oil pressure
   e. Engine coolant temperature gage
   f. Battery charge-rate ammeter
   g. START - STOP switch for manual operation of unit
   h. Reset main circuit breaker
   i. Static voltage regulator
   j. Voltage-adjusting rheostat for plus or minus 5% voltage adjustment
   k. Running time indicator
   l. Frequency meter, 3.5” dial type
   m. Panel illumination lights and switch

   1) Solid State 12 Light Engine Monitoring System to include the following:
      a) Run (green light)
      b) Overcrank Shutdown (red)
      c) Overspeed Shutdown (red)
      d) High Coolant Temperature Shutdown (red)
      e) Low Oil Pressure Shutdown (red)
      f) Pre-warning for High Coolant Temperature (yellow)
      g) Pre-warning for Low Oil Pressure (yellow)
      h) Low Coolant Temperature (yellow light indicated inoperative coolant heater)
      i) Switch Off (flashing red indicates genset not in automatic start mode)
      j) Low Fuel Day Tank (yellow)
      k) Low Fuel Main Tank (yellow)
      l) One customer selected fault (red)

2. Instrument panel shall meet annunciation requirements of NFPA 110 for a Level 1 system.

E. Alternator:

1. Brushless Alternator: The alternator shall be a 4-pole, revolving field design with temperature compensated solid state voltage regulator and brushless rotating rectifier exciter system. No brushes shall be allowed. The stator shall be directly connected to the engine flywheel housing, and the rotor shall be driven through a semiflexible driving flange to insure permanent alignment. The insulation system shall be class H as defined by NEMA MG1-1.65. The three phase, brushless, broad range, reconnectible alternators shall have be twelve leads reconnectible. The minimum motor-starting capability shall have a maximum voltage drop of 12%. Maximum alternator temperature rise shall not exceed 105 degrees C above a 40 degrees C ambient.
2. Alternator shall have field connections to allow for 480Y/277V or 208Y/120V operation.
3. Entrance Boxes: Provide factory installed entrance box extensions as an integral part of the generator set. The boxes shall be provided as necessary to allow for right or left, and top or bottom connections. Verify box requirements for cable entrances and conduit sizes and types prior to ordering of generator.

2.2 ENGINE-GENERATOR SET ACCESSORIES

A. Mainline Circuit Breaker(s)
   1. Provide a factory installed mainline circuit breaker(s) as an integral part of the generator set as indicated on the drawings. The mainline circuit breaker shall be sized in accordance with the manufacturer's recommendations and shall be 100% rated with electronic trip units. Breakers and trip units shall meet requirements of NEC 2005, Article 240.6.C.

B. Stand-Alone Diesel Tank
   1. Provide a stand-alone tank that is piped to the emergency generator connection by the PC. Provide 24 volt DC, normally closed fuel solenoid valve in diesel fuel supply line. Provide 2-#12 conductors in ¾” EMT conduit from solenoid valve to generator control panel. Tank shall be UL listed 142, double wall tank with leak detection. Leak detection shall audibly alarm at generator control panel and shall have an auxiliary contact for remote annunciation. Provide tank saddles to support tank. Tank shall be manufactured by Highland Tank or approved equivalent. Provide 2-#12 conductors in ¾” EMT conduit from each float switch on tank (total of two) to emergency generator control panel.

C. Remote Diesel Fill Station
   1. Furnish a remote diesel fill box for installation on exterior of building by PC. Fill box shall be equipped with high level fuel alarm control. Provide 4-#12 conductors in ¾” EMT conduit from fill box to diesel fuel tank.
   2. Schedule 40 black iron pipe shall be provided by PC from fill box to tank. All connections shall be threaded.

D. Exhaust Silencer and Piping
   1. Provide insulated super critical grade “pancake” exhaust silencer with drain, drain cock, and flexible connector, of types and sizes recommended by the generator manufacturer. Exhaust silencer shall be as manufactured by Maxim Silencers, Inc.
   2. Schedule 40 black iron exhaust pipe shall be provided by PC. All connections shall be threaded.

E. Battery/Starting System:
   1. Provide lead acid batteries, battery charger, battery rack, and battery cables as necessary for a complete battery/starting system.
   2. Batteries shall be sized to allow for a minimum of four 30 second cranking periods without recharging.
3. For exterior applications, provide battery blanket/heater capable of maintaining a battery temperature of 65 degrees F.

4. Provide battery cabling as required by manufacturer to limit voltage drop to an acceptable level. Locate batteries as close as practical to starting motor. Batteries shall be mounted on a nonconductive support/rack and in a location that permits ready access and maintenance.

5. Provide a float-equalize charger for battery charging system. Provide normal/emergency circuit in EMT conduit to battery charger.

6. Provide battery monitoring system to continually monitor and test batteries. System shall load test batteries each time engine starts, and shall indicate if batteries are weakened.

F. Anchors:

1. Provide anchor bolts of galvanized steel, of types and sizes recommended by the generator manufacturer.

2. Furnish anchor bolts to concrete formwork Installer with generator manufacturer's installation drawings and instructions.

G. Provide remote annunciator panel(s) for generator. Locate where indicated on drawings. Provide all wiring necessary from generator to remote annunciator panel(s) as required by generator manufacturer. All wiring shall be in conduit. Remote annunciator(s) shall not require a separate power connection, but shall be powered through the generator battery system. Communication to remote annunciator panel(s) shall be through networked communication cabling and not through the use of contact closures on wire pairs. Annunciator(s) shall operate up to 2000 feet from generator. Annunciator panel(s) shall meet annunciation requirements of NFPA 110 for a Level 1 system.

H. Provide exerciser clock to set the day, time, and duration of generator exercise period; also include "with/without load switch."

I. Provide an AC Voltmeter, an Ammeter, and a Frequency meter. Meters to be 2.5 inch, analog with 2% accuracy. Provide a phase selector switch to allow reading voltage and current line-to-line or three phase.

J. Provide engine generator emergency shutdown push button with guard and reset.

K. Miscellaneous Accessories: All accessories needed for the proper operation of the generating set shall be furnished. Provide 480 Volt Single Phase Jacket Water Heaters, and 5 sets of detailed operation and maintenance manuals with parts list.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which the engine-driven generator unit is to be installed and notify the Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.
3.2 GENERATOR BASE

A. Provide a 6" concrete pad for the generator as follows:

1. Coordinate size of generator pad with actual unit sizes provided. Construct base 4-inches larger in both directions than the overall dimensions of the supported unit.
2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad, 1" at a 45 degree angle.
3. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
4. Place concrete and allow to cure before installation of units. Use Portland Cement conforming to ASTM C 150, 3,000 psi compressive strength, and normal weight aggregate.

3.3 INSTALLATION OF DIESEL ENGINE-GENERATOR SET

A. Install the engine-generator unit as indicated, in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator units fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of engine-generator sets and accessories.

B. During installation, adjusting and testing of the standby emergency power system at construction site, retain and pay for the services of an approved, factory trained engineer or technician employed by the manufacturer of the engine generator set to technically supervise and participate during all adjustments and tests for the set and major auxiliaries in the presence of the Owner's representative.

C. Coordinate with other work, including raceways, electrical boxes and fittings, piping and accessories, as necessary to interface installation of engine-generator equipment work with other work. Provide strain relief/expansion fittings and flexible connections to generator for all wiring and conduit connections to generator. All wiring shall be stranded.

D. All fuel tanks, sub-base tanks, etc., shall be tested in the factory according to NFPA 30 and NFPA 37 requirements. In addition, after installation, and prior to putting generator in service, tanks shall be tested as required by NFPA 30, Section 4.4.

E. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A, B, and the National Electrical Code.

F. Install units on spring vibration isolators in accordance with the manufacturer's recommendations.

G. Align shafts of engine and generator within tolerances recommended by engine-generator unit manufacturer.

H. Provide a laminated or mounted under plexiglass set of approved operating instructions for the system. Install these instructions under a neat frame on the wall adjacent to the generator.
I. Provide a sign at the service entrance equipment indicating type and location of emergency generator.

J. Contractor shall provide lubricating oil, lubrication, coolant water treatment and anti-freeze solution, Prestone or as approved, to -30 degree Fahrenheit, in accordance with the manufacturer's instructions. Provide coolant additives to help protect the engine from corrosion. Use demineralized water in coolant mixture to help reduce corrosion in generator. Provide full tank of fuel with generator. Fuel for exterior generators shall be winter grade.

3.4 GROUNDING

A. Provide equipment grounding connections for the diesel engine-driven generator unit as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.5 FIELD QUALITY CONTROL

A. Start-Up Testing: Engage local equipment manufacturer's representative to perform start-up and building load tests upon completion of installation, with the Architect/Engineer in attendance; provide certified test record. Tests are to include the following:

1. Check fuel and lubricating oil for conformity to the manufacturer's recommendations under environmental conditions present.
2. Test prior to cranking engine for proper operation, accessories that normally function while the set is in a standby mode. Accessories include: engine/battery heaters, battery charger, remote annunciator.
3. Check, during start-up test mode, for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.
4. Test, by means of simulated power outage, automatic start-up by remote-automatic starting, transfer of load, and automatic shut-down. Prior to this test adjust, for proper system coordination, transfer switch timers. Monitor throughout the test, engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency.

B. Final site testing of the engine generator set and accessories shall not be less than four hours while carrying all available building loads supplemented by resistive load bank to achieve 100% of set's rating. Generator supplier shall supply load bank and cables as required to complete the above-mentioned test. Test shall simulate a full power outage to the building (i.e., shutting down of building utility source). All arrangements for final test shall be verified with the Owner prior to scheduling final testing.

C. Upon completion of installation demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting to be at no cost to Owner. At completion of testing and training, provide diesel fuel as necessary to fill fuel tank. Fuel for exterior generators shall be winter grade.
D. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating of diesel engine-driven generator sets. In addition, train Owner's personnel in periodic maintenance of batteries. Provide 16 hours of on site training for Owner’s personnel. Training shall be scheduled with Owner and shall be performed during off hours or weekends if requested by Owner.
SECTION 26 3353 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 REQUIREMENTS

A. The Supplier of the equipment defined in this Specification shall furnish all labor, materials and equipment, fabricate, assemble and test the Uninterruptible Power Supply (UPS) System at the factory. Transportation to the Owner's site shall be the responsibility of the manufacturer. The installation of the UPS shall be the responsibility of the Owner's contractor. During start-up of the UPS at the site, the Vendor's qualified representative shall test the system and instruct operating personnel in the operation of the equipment.

B. The UPS system shall be designed in accordance with the applicable sections of the following documents: NEMA, IEEE Inverter Standards, ASA, ASME, N.E.C. and OSHA. All components shall be listed by Underwriters' Laboratories, Inc. (UL), if such listing has been established for that component.

1.2 UNINTERRUPTIBLE POWER SYSTEM

A. This Specification defines an UPS comprised of one single power converter module capable of delivering conditioned power to the critical load. The UPS shall consist of a rectifier/charger, battery, redundant inverter, protective devices, static switch, unit synchronizing and phase lock to by-pass feeder equipment, control module, maintenance by-pass switching, instruments, control and indicators required to provide regulated uninterrupted conditioned power to the critical load.

B. The UPS shall include all mechanical and electrical devices that will automatically effect continuity of electrical power within the defined limits without interruptions upon failure or degradation of the commercial power source. Continuity of conditioned electrical power to the critical load bus shall be maintained for the defined period of time by the system battery. Upon return of the commercial power source, the rectifier/charger shall automatically recharge the battery.

1.3 DEFINITIONS

A. The UPS shall denote one power converter module with associated controls, displays and batteries, as required by the design.

1. Power Converter Module: Shall denote a rectifier/charger, inverter and static switch combination with its related control circuits, synchronizing equipment, protective devices and other auxiliary equipment required, including controls, instruments and indicators.
2. Rectifier/Charger: Shall denote that portion of a power converter module containing the equipment and controls to convert the incoming commercial power to precisely regulated DC power required by the inverter and for battery charging.
3. Internally Redundant Inverter: Shall denote that portion of the power converter module containing the inverter switching circuitry, logic circuits, synchronizing and timing circuits and other controls necessary to convert DC power to precisely regulated AC power required by the critical load.

4. Critical Load Bus: Denotes the load as presented to the UPS by the critical load and associated circuits and apparatus.

5. Mean Time Between Failure (MTBF): Shall denote an overall MTBF of the UPS as a complete system.

6. System Failure: Shall denote any interruptions to, or degradation of, the critical load bus voltage beyond the limits set forth herein. Successful transfer to the commercial or reserve power source, in the event of a failure of the UPS and retransfer to the UPS, shall not constitute a system failure.

7. Successful Transfer: Defined as an automatic and uninterrupted transfer of the critical load from, or to, the inverter without causing the degradation of the critical bus voltage beyond limits set herein.

8. Maintenance By-Pass Switching: Shall denote the capability of by-passing the total UPS and powering the critical bus from the reserve source. The by-pass shall be uninterrupted.

9. Static By-Pass Switch: Defined as a solid state switch capable of performing a successful transfer of the critical load from the inverter to the reserve source, or from the reserve source to the inverter.

10. Efficiency: Shall be the result of the total output KW divided by the total input KW under the following conditions:

   a. UPS operating at full load.
   b. Battery fully charged and floating on the DC bus.
   c. Input voltage at nominal.

PART 2 - PRODUCTS

2.1 OPERATION

A. When the commercial power is available, the rectifier/charger converts commercial AC power to DC power which it then supplies to the static inverter and battery. The battery is thus maintained in a fully charged condition. The static inverter converts the DC power from the rectifier/charger or battery to AC power, which is then supplied to the load.

B. As long as the operable inverter is supplied with DC, it shall supply AC power to the load. When the commercial power is not available, the battery shall maintain the flow of DC to the inverter and the inverter shall continue to supply the load without interruption for the specified duration. Restoration of the commercial power shall result in the battery being automatically recharged.

C. The static by-pass switch is normally open thus allowing the inverter output power to supply the critical load. Should the static inverter malfunction, the static by-pass shall automatically transfer the critical load to the reserve source without interruption of load power. The inverter will then automatically disconnect from the critical load.

1. Maintenance by-pass switching allows the critical load to be supplied from the reserve source during periods when the UPS is being maintained or repaired. The transfer shall
be make-before-break to assure load power continuity and also assure in phase transfer. Transfers to or from the UPS shall not degrade the critical bus beyond the limits specified.

2.2 RECTIFIER/CHARGER

A. The solid state Rectifier/Charger shall be a phase controlled, a minimum of six pulse type with constant voltage / constant current electronic control circuitry. It shall be capable of accepting the AC input voltage as specified herein and delivering DC power within specified limits to the inverter and battery.

1. Input Circuit Breaker: The primary power connection to the input of the rectifier/charger shall be through an automatic circuit breaker. The circuit breaker shall include suitable circuitry to provide "emergency power off" (EPO) functions. Detection and display of breaker position shall be provided.

2. Input Power Transformer: A dry type isolating power transformer shall be used to isolate the primary source from the UPS. The vacuum impregnated transformer shall have Class A insulation and shall be so located within the equipment to insure that the hottest spot shall not exceed the rated insulation temperature and to insure a low center of gravity. An electrostatic shield shall be used for noise isolation and suppression.

3. Filtering: Sufficient filtering of the rectifier/charger output shall be provided to prevent damage to the inverter and battery as well as to meet the limits specified herein. The filter capacitors shall be fused.

4. Current Inrush Limiting: The rectifier/charger shall provide suitable circuitry to reduce AC input current demand. When the primary power is applied to the rectifier/charger, the current surge (excluding transformer magnetization inrush) is gradually increased to full load rating.

5. Rectifier/Charger Capacity: The rectifier/charger shall have sufficient capacity to supply full load to the inverter plus recharge a fully discharged 15 minute battery to 95% of full capacity within 2.5 hours.

6. Automatic Equalize Recharging: The rectifier/charger shall provide automatic equalizing circuitry that can also be manually activated. A timer circuit shall be used to program the number of hours of equalize recharging following a battery discharge. The timer shall be adjustable in increments of 15 minutes up to at least 60 hours.

2.3 INVERTER

A. The solid state inverter shall be a pulse width modulated type capable of accepting the rectifier/charger output voltage or the battery voltage and delivering AC power within specified limits to the critical load. The inverter shall contain all necessary power, logic and control circuits.

B. Inverter Start-Up: The inverter shall automatically start-up and achieve stability within one second after the start command is initiated.

C. Inverter Oscillator: The inverter shall contain an oscillator capable of operating and maintaining the output frequency of the inverter as specified. The inverter oscillator shall be capable of frequency synchronization and phase locking to the reserve power source. If the reserve source is not available, the inverter oscillator shall automatically revert to a free running state and maintain the specified limits.
D. Filtering: The inverter shall include AC output filtering sufficient to meet limits specified herein. The filter shall be of the low pass design to insure that its characteristics remain unchanged over the entire synchronization range of the inverter.

E. Current Limiting: The inverter shall include suitable circuitry to prevent damage and to meet the limits specified herein for all excessive output loads including a short circuit. The opening of fuses shall not be permitted to achieve this function. Upon removal of the shorted or excessive load, the inverter shall resume normal operation without any degradation of performance or components.

F. Voltage Adjustment: The inverter AC output voltage shall be adjustable plus or minus 5% from nominal at full rated power.

G. Line Drop Compensation: The inverter shall include suitable circuitry to provide automatic line drop compensation so that its output voltage rises linearly in proportion to output current. The amount of compensation shall be adjustable from 0 to 5% at full rated load. No external voltage sensing shall be required to achieve this function. This function shall not interfere with other requirements specified herein. The sum of inverter output voltage adjustability and line compensation voltage shall not exceed the voltage adjustment range as specified herein.

H. Output Circuit Breaker: The inverter shall include a suitable circuit breaker to provide connection and/or isolation from the critical load bus. The circuit breaker shall include suitable circuitry to provide emergency power off (EPO) functions. Detection and display of breaker position shall be provided.

I. Logic Power Supply: A redundant logic power supply shall be provided. Loss of redundancy shall be detected and displayed.

J. Internal Redundancy: The inverter power conversion circuitry shall be arranged on identical modules. Redundant modules shall be included such that failure of any one module shall not result in loss of AC output voltage or degradation of full rated load performance beyond limits as specified herein. Loss of redundancy shall be detected and displayed. During operation without redundancy, the inverter shall meet all performance specifications except output overload rating and short circuit capacity.

K. Output Power Transformer: A dry type isolation power transformer shall be used at the inverter for isolation. The vacuum impregnated transformer shall have Class A insulation and shall be so located within the equipment to insure that the hottest spot shall not exceed the rated insulation temperature and to insure a low center of gravity. An electrostatic shield shall be used for noise isolation and suppression.

2.4 STATIC BY-PASS SWITCH

A. The static by-pass switch shall be all solid state and shall be capable of carrying rated load current continuously. Electro-mechanical switching devices to by-pass the static by-pass switch, except for maintenance, shall not be employed.

B. Reserve Transfer: The static by-pass switch shall automatically and successfully transfer the critical load from the inverter to the reserve source under the following conditions:
1. Inverter output voltage deviates beyond specified limits.
2. Critical load current exceeds overload rating of the inverter.
3. Over temperature develops within the inverter.
4. Manual (pushbutton) command is given.
5. Reserve transfer shall be automatically inhibited, whenever reserve power source conditions are outside predetermined (adjustable) limits, or the inverter and reserve are not synchronized and phase locked.

C. Retransfer: The static by-pass switch shall automatically and successfully retransfer the critical load from the reserve source to the inverter under the following conditions:

1. Critical load current is within the rated full load current of the inverter.
2. Retransfer selector switch is in "Automatic" position.
3. Retransfer shall be inhibited whenever the inverter and reserve power source are not synchronized and phase locked. A retransfer selector switch shall be provided to either inhibit or enable the retransfer operation.

D. Synchronizing Equipment: The inverter shall include all necessary circuitry for fully automatic synchronization and phase locking of the inverter to the reserve power source.

E. Maintenance By-Pass Switching: By-pass switching shall allow the critical load to be fed from the reserve power source while providing isolation of the inverter and static by-pass switch for safety during maintenance.

F. Logic Power Supply: Redundant power supplies with multiple power sources shall be provided. Loss of redundancy shall be detected and displayed.

2.5 COOLING

A. The UPS shall be forced air cooled. The UPS shall be equipped with redundant, permanently lubricated fans or blowers. Loss of redundancy shall be detected and displayed. Air inlets shall be equipped with standard type filters. Ambient temperature shall be monitored. Excessive ambient temperature shall be detected and displayed. Pressure differential switch shall be provided at the filter and wired to a local and remote alarm.

2.6 AUDIBLE NOISE LEVEL

A. Audible noise generated by the UPS shall not exceed 58 dB when measured 5 feet in front of the power converter and using scale A of a standard ASA sound level measuring device.

PART 3 - EXECUTION

3.1 GROUNDING

A. The UPS AC output power neutral shall be electrically isolated from the chassis. The inverter AC output neutral and the reserve AC input neutral (by-pass line) shall be connected to the UPS AC output neutral. The chassis shall be equipped with a suitable ground lug or stud. The equipment shall be design so that operation is not adversely affected by grounding the neutral.
The battery shall be isolated from the chassis except for ground fault sensing of 5000 ohms minimum.

3.2 PERSONAL SAFETY
   A. The UPS equipment shall be constructed so that access to internal areas containing live parts shall not be required for normal operation.

3.3 MAINTAINABILITY
   A. The equipment shall be designed so that required periodic servicing, circuit checking, troubleshooting, adjusting and parts replacing may be rapidly and safely accomplished.

3.4 ENCLOSURE
   A. UPS equipment shall be housed in a front access, free standing, ventilated enclosure with key lockable doors for convenient access.

3.5 QUALITY
   A. All materials, parts and components shall be new and of the highest grade. All metal surfaces, including copper and aluminum heatsinks and bus bars, shall be covered with suitable permanent protective coating. Power transformers shall be vacuum impregnated.

3.6 TESTING
   A. Each subassembly shall undergo a thorough test prior installation in the equipment. The complete equipment shall be functional and load tested and shall be subjected to a 72-hour "burn in" test without failure prior to shipment. The Customer shall have the right to witness the equipment test.

3.7 BATTERY
   A. The batteries shall be a maintenance free type.

3.8 ELECTRICAL CHARACTERISTICS – MDF ROOM
   A. Overall System Rating:
      1. 60 kVA, 8 kW at 0.8 lagging power factor to 60 kVA, 8 kW at unity (1.0) power factor.
   B. Primary Input Power Requirements:
      1. Primary AC input power for nominal voltages (phase-to-phase), 60 hertz shall be 480/277 volts, 3 phase, 4 wire, 72 Amps. full load current.
C. Output Power Requirements:

1. System AC output power for nominal voltages (phase-to-phase), 60 hertz shall be 120/208 volt, 3 phase, 4 wire, 166 Amps. full load current. Battery time of 10 minutes at full load and 30 minutes at half load.

3.9 APPROVED MANUFACTURERS

A. All equipment and pertinent data contained herein is intended to establish the standard of performance and quality and is based upon equipment designed and manufactured by APC/MGE or approved equivalents by Powerware and Liebert.

END OF SECTION 26 3353
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SECTION 26 3600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1  REFERENCE

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Requirements of the following Division 26 Sections apply to this section:
   1. 26 0100: Basic Electrical Requirements
   2. 26 0500: Common Work Results for Electrical

1.2  DESCRIPTION OF WORK

A. Provide automatic transfer switches (ATS) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer switch shall consist of an inherently double throw power transfer switch and a microprocessor controller to provide automatic operation. All ATSs and controllers shall be the products of the same manufacturer.

B. Provide delayed transition transfer switches (DTTS) with number of poles, amperage, voltage and withstand current ratings as shown on the plans. Each DTTS shall consist of a power transfer switch unit and a control panel interconnected to provide complete automatic operation. All DTTSs and controllers shall be the product of the same manufacturer.

   1. The DTTS shall transfer the load in delayed transition (break-before-make) mode. Transfer is accomplished with a user-defined interruption period in both directions adjustable from 1 second to 5 minutes in at least 15 increments.

1.3  SUBMITTALS

A. Product Data: Include ratings and dimensioned plans, sections and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

B. Wiring Diagrams: Detail wiring for transfer switches and differentiate between manufacturer installed and field installed wiring. Show both power and control wiring.

C. Single Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

D. Product Certificates: Signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for load ratings and short-circuit closing and withstand ratings applicable to units for Project.

E. Qualification Data: For firms and person specified in “Quality Assurance” article.
F. Field Test Reports: Indicate and interpret test and inspection results for compliance with performance requirements.

G. Maintenance Data: For each type of product to include in maintenance manuals specified in Division 1. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of automatic transfer switch equipment, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with automatic transfer switch units similar to those required for this project.

1. Agreement to Maintain: Engage Installer who is willing to execute with the Owner, required agreement for continued maintenance of the automatic transfer switch.

C. Codes and Standards

1. The transfer switches and controls shall conform to the requirements of:
   a. UL 1008: Standard for Transfer Switch Equipment
   b. IEC 947-6-1: Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment
   c. NFPA 70: National Electrical Code
   d. NFPA 99: Essential Electrical Systems for Health Care Facilities
   e. NFPA 110: Emergency and Standby Power Systems
   g. NEMA Standard ICS101993 (formerly ICS2-447): AC Automatic Transfer Switches
   h. UL 508: Industrial Control Equipment

D. Withstand and Closing Ratings

1. The transfer switch shall be rated to close on and withstand the available RMS symmetrical short circuit current at the transfer switch/bypass switch terminals with the type of overcurrent protection shown on the plans.
2. The transfer switch shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard’s 3 cycle ratings. Transfer switches/bypass switches that are not tested and labeled with a 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.
3. Transfer switches for the life safety system shall have a 30 cycle withstand rating, or when called for on the drawings. Transfer switches/bypass switches that are not tested and labeled with a 30 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.
E. Test and Certification

1. The complete transfer switch assembly shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

2. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

3. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation, and servicing in accordance with ISO 9001.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the transfer switch assembly properly packaged and mounted on pallets or skids to facilitate handling of heavy items. Utilize factory-fabricated type of containers or wrappings for transfer switch and components that protect equipment from damage.

B. Store the transfer switch equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle the transfer switch equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The transfer switch system shall be complete in every respect including all necessary equipment shown or not shown on the drawings to perform the functions relative to the system operation. All published specifications of the below manufacturers shall be considered as part of this specification even though they may not be shown in complete detail.

1. Manufacturer: Subject to compliance with requirements, provide automatic transfer switches of Cummins, GE/Zenith, or Russelectric.

2.2 MECHANICALLY HELD TRANSFER SWITCH

A. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators that include
overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.

B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.

C. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

D. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, that are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.

G. Where neutral conductors must be switched as shown on the plans, the transfer switch shall be provided with fully rated neutral transfer contacts.

H. Provide an external manual operating level which shall allow for manual operation of the transfer switch under load. Use of operation lever shall not require any part of the transfer switch enclosure to be opened.

2.3 MICROPROCESSOR CONTROLLER

A. The controller’s sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance and the ability to communicate serially through an optional serial communication module.

B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to ±1% of nominal voltage. Frequency sensing shall be accurate to ±0.2%. The panel shall be capable of operating over a temperature range of –20 to +60 degrees C and storage from –55 to +85 degrees C.

C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator’s manuals.
D. All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. IEEE472 (ANSI C37.90A) Ring Wave Test
2. ENC55011 1991 Class A Conducted and Radiated Emission
3. EN61000-4-2 Electrostatic Discharge Immunity, Direct Contact & Air Discharge
4. EN61000-4-3 Radiated Electromagnetic Field Immunity
5. EN61000-4-4 Electrical Fast Transient Immunity
6. EN61000-4-5 Surge Immunity
7. ENV50141 HF Conducted Disturbances Immunity

2.4 ENCLOSURE

A. The transfer switch assembly shall be furnished in a NEMA Type 12 enclosure unless otherwise shown on the plans.

B. All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement. All indicated lights shall be push-to-test, LED type. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.

2.5 CONTROLLER DISPLAY AND KEYPAD

A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

1. Nominal line voltage and frequency
2. Single or three phase sensing
3. Operating parameter protection
4. Transfer operating mode configuration (Open transition, Closed transition or Delayed transition)

B. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.6 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):
Parameter | Sources | Dropout/Trip | Pickup/Reset
--- | --- | --- | ---
Undervoltage | N&E, 3φ | 70 to 98% | 85 to 100%
Overvoltage | N&E, 3φ | 102 to 115% | 2% below trip
Underfrequency | N&E | 85 to 98% | 90 to 100%
Overfrequency | N&E | 102 to 110% | 2% below trip
Voltage unbalance | N&E | 5 to 20% | 1% below dropout

B. Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.

C. Voltage and frequency settings shall be field adjustable in 1% increments whether locally with the display and keypad or remotely via serial communications port access.

D. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

E. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage and current on all 3 phases, frequency, and phase rotation.

2.7 TIME DELAYS

A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

C. Two time delay modes (that are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

1. Prior to transfer only.
2. Prior to and after transfer.
3. Normal to emergency only.
4. Emergency to normal only.
5. Normal to emergency and emergency to normal.
6. All transfer conditions or only when both sources are available.
F. The controller shall also include the following built-in time delays for optional Delayed Transition operation:

1. 1 to 5 minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.
2. 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.
3. 0 to 5 minute time delay for the load disconnect position for delayed transition operation.

G. All time delays shall be adjustable in one second increments, except the extended parallel time, which shall be adjustable in 0.01 second increments.

H. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

2.8 ADDITIONAL FEATURES

A. A three-position momentary-type test switch shall be provided for the test/automatic/reset modes. The test position will stimulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.

B. A set of DPDT gold-flashed contacts rated 10 amps, 32 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of two contacts, closed when the ATS is connected to the normal source and two contacts closed, when the ATS is connected to the emergency source.

D. LED indicating lights (16mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green), one to indicate when the ATS is connected to the emergency source (red), one to indicate normal power is available (yellow) and one to indicate emergency power is available (yellow).

E. LED indicating lights (16mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset setting for each source.

F. Provide engraved nameplates for each light. Nameplates shall be attached using screws.

G. Terminals shall be provided for a remote contact that opens to signal the ATS to transfer to emergency and for remote contacts that open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

H. An In-phase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer.
I. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

J. The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:

1. Enable or disable the routine.
2. Enable or disable transfer of the load during routing.
3. Set the start time, time of day, day of week, week of month (1st, 2nd, 3rd, 4th, alternate or every)
4. Set the duration of the run.

K. At the end of the specified duration, the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

L. The controller LCD display shall include a “System Status” screen that shall be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.

M. The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller that may be preventing load transfer commands from being completed.

N. The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:

1. Event Logging
   a. Date and time and reason for transfer normal to emergency.
   b. Date and time and reason for transfer emergency to normal.
   c. Date and time and reason for engine start.
   d. Date and time engine stopped.
   e. Date and time emergency source available.
   f. Date and time emergency source not available.

2. Statistical Data
   a. Total number of transfers.
   b. Total number of transfer due to source failure.
   c. Total number of days controller is energized.
   d. Total number of hours both normal and emergency sources are available.

O. Provide a digital ammeter on the front of the ATS. Ammeter shall simultaneously display current on all three phases. Meter shall also store and display peak current values for each phase. Provide meter, necessary CT’s, shorting blocks, and all wiring at factory.
P. A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices.

2.9 FIELD WIRING

A. Provide all control wiring necessary between ATS(s) and generator(s) for startup and operation of emergency power system. All wiring shall be run in EMT conduit indoors, and rigid steel conduit outdoors or underground.

2.10 SERVICE REPRESENTATION

A. The transfer switch manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center’s personnel must be factory trained and must be on call 24 hours a day, 365 days a year. The service center must be located within a 75 mile radius of the project site.

B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years and guarantee availability of parts for the same time frame.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control testing under the supervision of the manufacturer’s factory-authorized service representative in addition to test recommended by the manufacturer:

1. Before energizing equipment, after transfer switch products have been installed:
   b. Check for electrical continuity of circuits and for short circuits.
   c. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   d. Verify that manual transfer warnings are properly placed.

2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Perform contact resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power and engine cool down and shutdown sequence.

B. Ground Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

1. Assist in verifying grounding connections and locations and ratings of sensors.
2. Assist in observing reaction of circuit-interrupting devices when simulated fault current is applied at sensors.

C. Coordinate tests with test of generator set and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.2 WARRANTY

A. The complete automatic transfer switch system shall be warranted for a period of five (5) from the date of initial start-up. The warranty must be provided by the system manufacturer, and shall include all parts and labor. Satisfactory warranty documents must be provided.

END OF SECTION 26 3600
SECTION 26 4113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENT

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Requirements of the following Division 26 Sections apply to this section:
   1. 260100: Basic Electrical Requirements
   2. 260500: Common Work Results for Electrical

1.2 DESCRIPTION OF WORK

A. Provide a complete lightning protection system as described hereinafter. Provide full coverage of the existing and new building, including, but not limited to, all roof ridges, and roof perimeters.

B. Types of lightning protection system material and components specified in this section include the following:
   1. Air terminals.
   2. Bonding plates.
   3. Conductors.
   4. Connectors.
   5. Grounding rods.
   6. Rod clamps.
   7. Splicers.
   8. Wire.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of lightning protection system components, of types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 2 years.

B. Manufacturers: Firms regularly engaged in manufacture of lightning protection system components, of types, sizes, and ratings required, and who are Class I manufacturer-members of Lightning Protection Institute.

C. Installer's Qualifications: Firm with at least 2 years of successful installation experience with projects utilizing lightning protection systems similar to that required for this project.

D. NEC Compliance: Comply with NEC requirements pertaining to lightning (surge) arresters, grounding, grounding electrodes, and down conductor clearances.
E. NFPA Compliance: Comply with requirements of NFPA No. 78, "Lightning Protection Code", as applicable to lightning protection systems for building projects.


G. UL Compliance: Comply with Master Label provisions of UL 96A, "Installation Requirements for Lightning Protection Components". Provide components that are UL-listed and labeled.

H. LPI Compliance: Comply with requirements of Lightning Protection Institute (LPI) Standards 175, 176, and 177, pertaining to lightning protection system material, components, installation and testing procedures.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data on lightning protection systems and associated components.

B. Shop Drawings: Submit layout drawings of lightning protection system equipment and components including, but not limited to, conductor routing, connections, roof penetration details, and grounding.

C. UL Certification: Provide Owner with UL Master Label for overall system that is suitable for fastening to building for display purposes. Comply with UL 96A, "Master Labeled Lightning Protection Systems".

PART 2 - PRODUCTS

2.1 ACCEPTABLE INSTALLERS

A. Subject to compliance with requirements, installers offering lightning protection components that may be incorporated in the work include, but are not limited to, the following:

1. Ace Lightning Protection Co., Pittsburgh, PA (724)-733-5216
2. Maxwell Lightning Protection, Dayton, OH (937)-228-7250
3. East Coast Lightning Equipment Inc., Winsted, CT 860-379-9072

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. General: Provide lightning protection system material and components, of types, sizes, ratings for Class 1 service, that comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for a complete installation. Where type components or materials are not otherwise indicated, comply with NFPA 78 and LPI standards.

B. Class 1 Installations Materials:

1. Air Terminals: Solid copper; minimum diameter 3/8" (9.5mm).
2. Main Conductors: Copper cable; minimum size strand diameter, 0.045" (1.150mm - 17 AWG); 0.187#/ft (278 g/m); 57,400 circular mils (29mm sq.).

3. Secondary Conductors: Copper cable; minimum size strand diameter 0.045" (1.150mm - 17 AWG); number of wires 14.

2.3 ANCILLARY COMPONENTS

   A. Connectors: Bronze right-angle thru-roof cable connector; bronze and lead seal flashing washer, 1/2" x 8" threaded stem, to fit 6" roof thickness.

   B. Connectors: 4" bronze parallel bonding clamp for connecting 1/0 or 2/0 cables.

   C. Splicer: Bronze straight cable splicer for splicing No. 4 and No. 6 cables.

   D. Splicer: Bronze pressure type "T" cable splicer for clamping standard cables through 2/0, with hex bolts and washers.

   E. Splicer: Bimetal straight splicer of cast aluminum and bronze for 2/0 cable with moisture tight sealing capability.

1. Ground Rod: Solid copper clad steel 3/4" dia. x 10'

PART 3 - EXECUTION

3.1 INSTALLATION OF LIGHTNING PROTECTION SYSTEMS

   A. Install lightning protection systems as indicated, in accordance with equipment manufacturer's written instructions, and in compliance with applicable requirements of NEC and NFPA 78 to ensure that lightning protection systems comply with requirements.

   B. Coordinate with other work, including electrical wiring and roofing work, as necessary to interface installation of lightning protection system with other work.

   C. Install conductors with direct paths from air terminals to ground connections avoiding sharp bends and narrow loops.

   D. Install all conductors (except as noted below) concealed inside structure. Provide conduit sleeves at roof, wall, and other structural penetrations. Coordinate locations and routing of conductors with the Architect before ordering material. Install conductor running length of roof ridge exposed.

3.2 GROUNDING AND BONDING

   A. Provide equipment grounding and bonding connections, sufficiently tight to assure permanent and effective grounds and bonds, for lightning protection connection devices as indicated.
3.3 TESTING

A. Upon completion of installation of lightning protection system, test resistance-to-ground (earthing connecting) with resistance tester. Where tests indicate resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms or less, by driving additional, properly spaced, ground rods, and treating soil in proximity to ground rods with common salt, copper sulfate or magnesium sulfate. Then retest to demonstrate compliance.

B. Perform resistance-to-ground tests of lightning protection system periodically, at 6 month intervals or less, following time of substantial completion and submit written report indicating results. Where resistance is greater than 5 ohms, chemically treat soil to reduce resistance to 5 ohms or less, then retest to demonstrate compliance.

3.4 PERSONNEL TRAINING

A. Building Maintenance Personnel Training: Train Owner's building maintenance personnel in procedures for testing and determining resistance-to-ground values of lightning protection system. Also instruct maintenance personnel in preparation and application of chemical solution for earth surrounding grounding rods for reducing ohmic resistance to required levels.

END OF SECTION 26 4113
SECTION 26 4313 - T.V.S.S

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The following technical specification describes the requirements of the Parallel Design Transient Voltage Surge Suppression (TVSS) System. The TVSS system utilizes multiple Bi-Direction Protection Modules to suppress and divert transient voltages and surge currents. The system is designed to provide protection for sensitive electronic devices against the harmful effects of surges, transients, and electrical line noise.

B. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

C. This section is a part of each Division 26 section making reference to TVSS specified herein.

D. Requirements of the following Division 26 Sections apply to this section:
   1. 260100: Basic Electrical Requirements
   2. 260500: Common Work Results for Electrical

1.2 DESCRIPTION OF WORK

A. The following technical specification describes the requirements of Series and Parallel Design Transient Voltage Surge Suppression (TVSS) System. The TVSS system utilizes multiple Bi-Direction Protection Modules to suppress and divert transient voltages and surge currents. The system is designed to provide protection for sensitive electronic devices against the harmful effects of surges, transients and electrical line noise.

B. TVSS units are indicated on the drawings. Units are specified by part numbers that indicate the required ratings (i.e., maximum surge current, clamping voltage), and system noise filter networks. Required accessories (i.e., status indicators, alarms, transient counters) shall be provided as specified herein.

1.3 STANDARDS

A. The Parallel Design Transient Voltage Surge Suppression System shall be designed and manufactured to the following standards:

   1. Underwriters Laboratory (UL) 1449-Second Edition Revised
   2. Underwriters Laboratory (UL) 1283
   4. American National Standard Institute (ANSI)
   5. Institute of Electrical and Electronic Engineers (IEEE)
   6. National Electrical Manufacturers Association (NEMA)
   7. National Fire Protection Association (NFPA)
8. Occupational Safety and Health Act (including Pub. 81-123)

B. In addition, the TVSS system shall be tested in accordance with the following standards:

1. ANSI/IEEE C62.41, Categories A, B and C3
2. ANSI/IEEE C62.45
3. Military Standard 220A
4. Underwriters Laboratory - UL 1449

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of surge protection of the types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects utilizing surge protection similar to those required for this project.

C. TVSS Units shall be UL listed to sections 1283 and 1449 Second Edition and the rating shall be permanently affixed to the TVSS.

D. Main service units shall meet ANSI/IEEE C62.41 category C.3.

E. All units shall comply with ANSI/IEEE C62.45 withstanding a minimum of twenty-five hundred 10,000 ampere impulses.

F. The TVSS system shall be tested in accordance with the following standards:

1. ANSI/IEEE C62.41, Categories A, B and C
2. ANSI/IEEE C62.45
3. Military Standard 220A
4. Underwriters Laboratory - UL 1449 Second Edition
5. Units installed at the main service shall meet ANSI/IEEE C62.41 category C.3.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's data on surge protection including, but not limited to, operating voltages, clamping voltage, modes of protection, surge current ratings (all modes of protection), frequencies, parts list, schematic drawings and a theory of operations manual. When an internal disconnect is specified herein the product data shall include the addition of the disconnect.

B. A line item by line item specification compliance matrix is required in the submittal package to assist the Engineer in the approval process.

C. Provide a copy of the manufacturer's UL 1283 and UL 1449 files, and the test data verifying compliance to ANSI/IEEE C61-41-C.3 AND C62.45.
D. Provide documentation of proper fuse coordination of actual fault tests from a nationally recognized testing laboratory.

E. Shop Drawings: Submit layout drawings of surge protection showing accurately scaled basic equipment sections including auxiliary compartments, section components, and combination sections.

F. Wiring Diagrams: Submit wiring diagrams for surge protection showing connections to line and load side electrical power feeders. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.

G. Submit catalog data on all materials with complete description of material components. Equipment using epoxy covered or sealed components shall furnish complete schematics and parts list with submittals.

PART 2 - PRODUCTS

2.1 ENVIRONMENTAL REQUIREMENTS

A. The TVSS system shall be designed for operation in the following conditions:

- Operating Temperature: -40°C to 60°C
- Relative Humidity: 0 - 95%
- Operating Altitude: 0 - 12,000 Feet
- Audible Noise: Less than 35 DBA at 3 feet

2.2 ELECTRICAL REQUIREMENTS

A. The TVSS System shall have unlimited nominal current handling when installed in a parallel configuration.

B. The system voltage shall be 480 VAC, 3 Phase, 4 Wire plus ground at 60 Hertz.

C. The Transient Voltage Surge Suppression System shall be a three stage device capable of suppressing (160,000) amperes per phase.

D. The TVSS System's mode of operation shall protect against surges and transients as follows:

<table>
<thead>
<tr>
<th>System Configuration</th>
<th>Protection Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Phase, Two Wire (L,N) + Ground</td>
<td>L to G, L to N, and N to G</td>
</tr>
<tr>
<td>Single Phase, Two Wire (L,L) + Ground</td>
<td>L to L, and L to G</td>
</tr>
<tr>
<td>Split Phase, Three Wire + Ground</td>
<td>L to G, L to N, and N to G</td>
</tr>
<tr>
<td>Three Phase, Three Wire (Delta) + Ground</td>
<td>L to L, and L to G</td>
</tr>
<tr>
<td>Three Phase, Four Wire (Wye) + Ground</td>
<td>L to G, L to N, and N to G</td>
</tr>
</tbody>
</table>

E. The TVSS System shall have unlimited nominal current handling when installed in a parallel configuration.
F. Equipment in this Specification and shown on the Drawings is based on products manufactured by Innovative Technologies and other specific manufacturers, and is intended as the standard equipment to be furnished, or as approved. Unit part numbers are shown on the drawings. These part numbers are used to establish the minimum acceptable ratings for each device and all manufacturer's published specifications pertaining to this specialization shall have the same force and effect as if shown here in full. Units provided by other manufacturers shall meet or exceed the ratings of the specified part number. Being listed as an acceptable manufacturer does not preclude the listed manufacturers from complying with this specification.

G. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. L.E.A. Dynatech
2. Liebert Corporation
3. Eaton – Innovative Technology

H. System Voltage: The system voltage, a number of phases, and number of wires shall be as shown on the drawings.

I. Maximum Continuous Operating Voltage (MCOV)

1. The TVSS maximum continuous operating voltage shall be greater than 110% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS overvoltage conditions.

J. Overcurrent Protection

1. All protection modes of the TVSS shall be internally fused at the component level with the fuses \( I^2T \) capability to allow the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. If the rated \( I^2T \) characteristic of the fusing is exceeded, the fusing shall be capable of opening in less than one millisecond and clear both high and low impedance fault conditions. The fusing shall be capable of interrupting up to 300 KA symmetrical fault current with 600 VAC applied. This overcurrent protection circuit shall be monitored and provide indication of suppression failure/operability.

K. Operating Parameters

1. The maximum response time shall not exceed 1 nanosecond
2. The system shall operate over a frequency range of 45 hertz to 63 hertz.
3. The system shall limit total harmonic distortion produced to less than one percent.
4. The system's filtering mode shall provide sinewave tracking to within \(+/-20\%\).
5. The system performance ratings shall be based on the UL 1449 listing ratings for IEEE C62.41 Category B impulse waveforms of 600 volts 1.2 x 50 microseconds, 3000 amperes 8 x 20 microseconds equipment.
6. The TVSS shall be provided with a Noise Filtering System capable of managing noise levels produced by electro-magnetic interference and radio frequency interference. The system shall provide 50 dB of noise attenuation as well as redundant noise filters in both the L-G and L-N mode to insure a failure of a filter does not cause noise problems.
L. Suppression topology shall be a hybrid platform consisting of both Silicon Avalanche Diodes (SAD) and Metal Oxide Varistors (MOV). Systems that do not contain Silicon Avalanche Diodes are unacceptable.

M. The Parallel Design Product shall be provided with a Noise Filtering System capable of managing noise levels produced by electro-magnetic interference and radio frequency interference.

N. The UL1449 Second Edition Ratings for Clamping Voltage values shall be no greater than those shown as follows:

<table>
<thead>
<tr>
<th>Pathway</th>
<th>480</th>
<th>277/480</th>
<th>120/208</th>
<th>120/240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line-Neutral</td>
<td>N/A</td>
<td>500 VAC</td>
<td>330 VAC</td>
<td>330 VAC</td>
</tr>
<tr>
<td>Line-Ground</td>
<td>N/A</td>
<td>700 VAC</td>
<td>330 VAC</td>
<td>330 VAC</td>
</tr>
<tr>
<td>Neutral-Ground</td>
<td>N/A</td>
<td>330 VAC</td>
<td>330 VAC</td>
<td>330 VAC</td>
</tr>
<tr>
<td>Line-Line</td>
<td>1200 VAC</td>
<td>1200 VAC</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

O. Enclosure; NEMA 12

2.3 ENVIRONMENTAL REQUIREMENTS

A. The TVSS system shall be designed for operation in the following conditions:

- Operating Temperature: -40 C to 60 C
- Relative Humidity: 0 - 95%
- Operating Altitude: 0 - 12,000 Feet
- Audible Noise: Less than 35 DBA at 3 feet

B. Unit Status Indicators

1. Red and green solid state indicators (LEDs) with printed labels shall be provided on the hinged front cover to continuously indicate unit module status. The absence of the green light and the presence of the red light shall reliably indicate that one or more surge current diversion modules has failed and that service is needed to restore full operation.

2. Provide a Form C (one N.O. and one N.C.) summary alarm contact rated for at least 120 VAC and 1 ampere for remote annunciation of unit status. The summary alarm contact shall change state if any one or more of the surge current diversion modules has failed.

3. Provide an audible alarm that shall be activated when any one or more of the surge current diversion modules has failed. In conjunction with the audible alarm, provide an alarm ON/OFF switch to silence the alarm and an alarm "push-to-test" switch to test the alarm function. Both switches and the audible alarm shall be located on the units hinged front cover.

4. Provide a transient voltage counter that will display the total number of transient voltage surges that deviate from the sine wave envelope by more than 125 volts. The readout shall be at least a six digit LCD located on the unit's hinged front cover. The counter shall be equipped with a battery back-up to retain memory when power is not present. Provide a push-button switch on the display's faceplate for counter reset.
C. The transient voltage surge suppression system shall consist of a hybrid technology consisting of multiple SAD/MOV circuits designed to suppress transient voltage and divert excess surge currents. The system shall be designed and UL 1449-Second Edition listed to suppress the surge current per each protection mode of protection as detailed in this specification.

D. Each suppression pathway contains 200 kAIC fused 40 mm Metal Oxide Varistors rated to dissipate 80,000 amperes of surge current each.

E. Each individual MOV within the system shall be designed to dissipate multiple IEEE C62.41 Category C3 (20 kV, 10 kA) events.

F. The TVSS system shall consist of a number of individual pathway protection modules designed to suppress and divert transient voltages and surge currents. Each protection module shall be rated to suppress a minimum of 80,000 amperes of surge current. These protection modules shall contain one or more individually fused Metal Oxide Varistor(s) each capable of withstanding Category C3 (IEEE/ANSI C62.41) currents rated at 10,000 amperes minimum.

G. Each protection module shall contain a green light, a red, and a yellow light for easy viewing. The normal operation of the protection module shall provide positive indication utilizing the green light. Failure of the protection module shall provide negative indication utilizing the red light. Indication of module failure is duplicated on the outside front door of the enclosure providing a summary visual alarm utilizing the green and red lights. In addition to the above, each module (except N-G) shall be housed in a clear casing allowing for visual inspection of the internal components.

H. The protection modules shall be provided with an octal pin assembly capable of being easily inserted into and removed from a matching base. This attachment method provides a firm fit while allowing for quick and easy field replacement. Each module shall feature a retaining clip to ensure firm module “seating” for reliability and ease of field replacement. The protection modules shall be UL 1449 Second Edition recognized as a component of the overall system. The aspect of field replaceable individual protection modules is a strict requirement of this specification.

I. For larger surge current rated systems that require multiple 80kA protection modules per each pathway, the architecture of the system shall include a copper bus bar system to remove interconnect wire, wire bends, and other aspects that would reduce the performance characteristics of the system.

J. Each protection module shall contain filtering elements capable of providing valuable noise attenuation characteristics. The TVSS system shall also include a separate noise filtering system that works in conjunction with the filtering internal to each protection module to increase the overall TVSS system's noise filtering rating per the manufacturer’s specification.

K. The use of gas discharge devices or selenium rectifier systems is expressly forbidden.

L. Spare Module - Provide one Spare Protection Module with the unit for on-site spare parts purposes.

M. A failure of any protection module shall cause the form C contact to change state, thus providing for remote alarming of the condition.
N. The system's on-board monitoring shall include a six (6) digit Surge Event Counter. The counter shall increment any surge event where the SAD/MOV hybrid circuit actually diverts current to its assigned pathway. Systems that increment the counter only when there is a high surge voltage event (and not necessarily actual surge diversion) are not acceptable for use on this project. The counter shall be provided with a (5) year lithium battery for information retention purposes in the event of a complete power failure.

O. This specification acknowledges that there are TVSS systems with either continuous on-board monitoring of each suppression component complete with local diagnostics integral to the TVSS system, or systems that require the use of external diagnostic test equipment to enable the user to identify when a suppression component has failed.

1. Systems that feature a monitoring circuit designed such that an MOV can fail (resulting in reduced surge current capacity levels with that failure not indicated on the system's monitoring panel), the manufacturer shall provide a diagnostic test kit with each TVSS system specified.

P. The TVSS system shall be provided with a monitoring panel complete with mounting bezel and an integral Status Panel. The Status Panel shall contain five (5) LED's indicating the following:

1. Input AC On
2. System Ready
3. System Fault
4. Alarm No. 1
5. Alarm No. 2

2.4 CABINET CONSTRUCTION

A. The cabinet enclosure shall be designed for wall mounting. The cabinet shall be aesthetically pleasing and shall be dimensioned as 24"W, 20"H and 9"D.

B. The cabinet enclosure shall be rated NEMA 12 for indoor applications.

PART 3 - EXECUTION

A. Installation

1. Install the TVSS in accordance with the manufacturer's recommended installation practices and all applicable codes.

B. System Testing and Installation:

1. The manufacturer shall own and operate a surge simulation system that creates an IEEE C62.41 Category C3 (20 kV, 10 kA) surge event. Each unit must be tested on this test fixture and results commensurate with the IEEE and UL 1449 Second Edition standards shall be shipped with the system to the job site.

2. A representative from the consulting engineer or the end user shall be welcome to witness test the system(s) at the manufacture. It shall be the cost of the end user to attend such tests if so desired.
3. The manufacturer shall have a contracted and trained local representative to visit the site to assist the user in the proper installation of the system to ensure maximum performance.

C. Warranty and Service:

1. The TVSS system manufacturer shall warrant the entire system against defective materials and workmanship for a period of five years following delivery from the manufacturer. The internal TVSS protection modules shall be protected by a five year warranty following delivery from the manufacturer providing the protection modules are not subjected to misuse or over-exposure. This warranty is in effect as long as the unit is installed in compliance with the manufacturer's owner's/operator's manual, UL listing requirements, and any applicable national or electrical codes.

2. The manufacturer is required to have a nationwide network of factory trained technicians dedicated to repair and service of this product. The manufacturer shall have a dedicated 1-800 telephone number for service problems and questions. This number must be manned 24 hours a day, 365 days a year by a knowledgeable factory employee to ensure prompt response to any emergency situation, that may arise. The manufacturer is required to be able to service the equipment on a local basis without the requirement to return the product to the manufacturer for proper repair.

D. Extended Maintenance:

1. The Surge Suppressor shall have as an optional feature extended service contract maintenance.

END OF SECTION 26 4313
SECTION 26 5100 - LIGHTING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Requirements of the following Division 26 Sections apply to this section:

1. Section 260500: Common Work Results for Electrical
2. Section 260529: Hanger and Supports for Electrical Systems

1.2 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures with lamps and ballasts.
2. Exit signs.
3. Lighting fixtures mounted on exterior building surfaces.
4. Emergency lighting units.

B. Related Sections include the following:

1. Division 260923 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.
2. Division 260933 Section “Architectural Dimming Controls”
3. Division 260943 Section “Network Lighting Controls” for manual or programmable control systems with low-voltage control wiring or data communication circuits.
4. Division 265561 Section "Theatrical Lighting" for theatrical lighting fixtures and their controls.

1.3 DEFINITIONS

A. Fixture: A complete lighting unit or exit sign. Fixtures include lamps and parts required to distribute the light, position and protect lamps, and connect lamps to the power supply.

B. Luminaire: Complete lighting fixture, including ballast housing if provided.

C. Average Life: The time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

D. BF: Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.
E. CRI: Color rendering index.
F. CCT: Correlated Color Temperature
G. CU: Coefficient of utilization.
H. HID: High-intensity Discharge.
I. Lumen: Measured output of lamp and luminaire, or both
J. FC: Footcandle
K. RCR: Room cavity ratio.
L. LER: Luminaire efficiency rating that is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:

1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.

1.4 SUBMITTALS
A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Submit the following with the Light Fixture shop drawing in booklet form:
   a. Separate cut sheet for each fixture type listed in the lighting fixture schedule, assembled in "luminaire type" alphabetical-numerical order, with proposed fixture and accessory catalog numbers clearly indicated on each sheet.
   b. Physical description of fixture, including dimensions and verification of indicated parameters.
   c. Submit lamp and ballast cut sheets for each different type of lamp and ballast.
   d. Where a specific color is not specified and options exist, submit color and/or finish samples for selection by Architect. Fixtures not acceptable to the Architect for color and/or finish shall be replaced at no additional cost.
   e. Electrical ratings and photometric data with specified lamps in accordance with published IES testing procedures and certified results of laboratory tests. In addition, for alternate manufacturers, data shall be supplied in the form of a data file on CD-ROM in IES standard format for use in a recognized computer lighting analysis program.
   f. Luminaire effective projected area, details of attaching luminaires, accessories, and installation and construction details.
   g. Luminaire materials.
   h. Emergency lighting unit battery and charger.

B. Electrical Characteristics Summary

1. Prepare a listing of the electrical ratings and characteristics for each individual lighting fixture type. Listing shall include:
a. Fixture tag, as indicated on the Lighting Fixture Schedule,
b. Short fixture description limited to 12 characters,
c. Wattage, as stated in the Lighting Fixture Schedule,
d. Normal running current,
e. Normal running power factor, indicating ‘+’ for leading power factor and ‘-‘ for lagging power factor,
f. Starting current,
g. Starting power factor, indicating ‘+’ for leading power factor and ‘-‘ for lagging power factor, and the duration of the starting current,
h. Harmonics, only if greater than 10%THD.
i. Values for c. through h. above may be stated in a range of values.

2. Summary shall be in table form, in landscape format, on 8 ½” x 11” paper.
3. Summary shall be included at the beginning of each shop drawing submittal, after the index but before the individual fixture cut sheets.
4. Failure of the Contractor to submit the above referenced summary, or an incomplete or inaccurate summary shall result in the Contractor taking full responsibility for replacement of the lighting fixture in the event that the fixture has a negative impact on the electrical distribution system.

C. Shop Drawings:

1. Detailed scaled shop drawings of all pendant mounted linear fluorescent fixture systems containing the following information: support canopy type, support spacing, pendant type, power feed type and locations, fixture joint locations, trim details, closure piece details, end plates, corner details, and continuous louver or lens details, where applicable.

D. Wiring Diagrams:

1. Power, signal, and control wiring.
2. Submit wiring diagrams for electrical poles and standards showing connections to branch circuit wiring, switches, ballast, and controls. Differentiate between portions of electrical wiring, that are manufacturer-installed and portions, that are field installed.

E. Source quality-control test reports.

F. Product Certificates: Signed by manufacturer of poles, certifying that products are designed for load requirements in AASHTO LTS-3 and that load imposed by luminaire has been included in design.

G. Operation and Maintenance Data:

1. For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:
   a. Catalog data for each fixture. Include the diffuser, ballast, and lamps installed in that fixture.
2. Submit maintenance data and parts list for each lighting fixture and accessory, tools required, cleaning methods and materials, and including "trouble-shooting" maintenance guide.
3. Warranties:
   a. Special warranties specified in this Section.

H. Fixture Samples:
   1. Manufacturers shall be prepared to submit complete fixture samples for approval by Architect and Engineer. Samples shall be submitted only at the request of the Architect/Engineer. Sample fixtures shall be shipped prepaid by the Contractor and shall be furnished within two weeks of request. Fixtures shall be complete with specified lamps and mounting hardware. Samples shall be evaluated for two weeks prior to acceptance or rejection. Samples shall remain on the project site as an example of materials, workmanship, finish, color, tolerance, performance, and general quality of all other fixtures of the respective type to be installed on the project. Fixtures judged inferior to the sample shall not be accepted. The Architect/Engineer shall be the final judge of fixture acceptance.

1.5 ILLUMINATION DATA
   A. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
      b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.6 QUALITY ASSURANCE
   A. Alternate manufacturers: As listed in the fixture schedule. The alternate manufacturers are presented as possible sources of the specified fixture. The listing of a manufacturer as an alternate does not guarantee that manufacturer will have a fixture equal to the specified fixture. Approval of manufacturers, considering their products equal, will be subject to review by the Specifier.
   B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with lighting fixture work similar to that required for this project.
   C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
      1. Provide fixtures for use in damp or wet locations.
D. Codes and Standards:

1. NFPA 70: Comply with "National Electrical Code" for components and installation, including articles 220, 250, 410, 501, and 700 as applicable to the installation, and the local code requirements of the authority having jurisdiction.

2. NFPA 101: Comply with visibility and luminance requirements for exit signs.

3. NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/Nos. pertaining to lighting equipment.

4. IES Compliance: Comply with IES RP-1-93 pertaining to office lighting practices and RP-16-96, regarding selection of illuminance values for interior lighting. Comply with RP-3-00 for Educational Facilities. Comply with IES RP-8-00, RP-20-98, and RP-33-99 pertaining to exterior, parking, and roadway lighting practices and fixtures. Comply with RP-6-01 pertaining to sports and recreational facilities.


6. UL Compliance: Comply with UL standards, including Stds 486A and B, pertaining to fixtures and UL 1570 pertaining specifically to fluorescent fixtures. Comply with UL 935 standard for fluorescent ballasts. Provide lighting fixtures and components that are UL-listed and labeled.

7. ANSI Compliance: Electronic fluorescent ballasts shall comply with ANSI C82.1, C82.11, C82.2 and C82.3. These standards are the basis for the Certified Ballast Manufacturers certification program. C82.1 covers electromagnetic ballast performance and C82.11 covers electronic ballast performance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver lighting fixtures and accessories in factory-fabricated containers or wrappings that properly protect fixtures from debris and physical damage.

B. Handle lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; replace with new.

C. Store lighting fixtures in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

1.8 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrate ceilings or are supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. Sequence lighting fixture installation with other work to reduce the possibility of damage and soiling of fixtures during remainder of construction period.

1.9 WARRANTY

A. Special Project Warranty: Submit a warranty, mutually executed by Manufacturer and the Installer, agreeing to replace equipment that fails in materials or workmanship within the special
project warranty period specified below. This warranty is in addition to, and not a limitation of, other rights and remedies the Owner may have under the Contract Documents.

B. Special Warranty for Emergency Lighting Unit Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

C. Manufacturer's Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Three years from date of Substantial Completion.

D. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: 5 years from date of manufacture.

E. Plastic and acrylic lenses: Plastic and acrylic lenses shall be warranted against dimensional instability, discoloration, embrittlement, or loss of light transmittance for a minimum of 10 years, if any of these occur the manufacturer shall replace the product.

F. Alzak reflectors and louvers: Alzak reflectors and louvers shall be warranted against discoloration for a minimum of 10 years, if discoloration occurs the manufacturer shall replace the product.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten percent (10%) of the total quantity of lamps for each lamp type/wattage, rounded down to the nearest whole number. Furnish at least one (1) of each lamp/wattage type.

2. Ballasts: One percent (1%) of each type and rating installed, rounded down to the nearest whole number. Furnish at least one (1) of each type and rating.

3. Plastic Diffusers and Lenses: One percent (1%) of each type installed, rounded down to the nearest whole number. Furnish at least one (1) of each type.

4. Globes and Guards: Five percent (5%) of each type installed, rounded down to the nearest whole number. Furnish at least one (1) of each type.
PART 2 - PRODUCTS

2.1 LAMPS

A. Manufacturers: Subject to compliance with the fixture manufacturer's requirements and recommendations, provide products from the following:

1. Philips
2. Osram/Sylvania
3. General Electric
4. Venture (Metal Halide Sources Only)

B. General:

1. All fixtures of the same type shall be furnished with the same manufactured lamp type, unless specifically noted otherwise. All lamps of the same type shall be from the same manufacturing plant to assure consistency in color and quality control.
2. Lamp color temperature, rated in degrees Kelvin shall be as indicated in the lighting fixture schedule.
3. General lamp shape, wattage, and distribution shall be as indicated in the lighting fixture schedule.
4. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test (TCLP), and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL1.
5. All spent fluorescent and HID lamps shall be disposed of by the contractor according to NEMA guidelines, the Universal Waste Rule, and the requirements of local and state authorities having jurisdiction. The Universal Waste Rule shall only apply to non TCLP conforming lamps.

C. Incandescent:

1. All A-shape lamps shall be inside frosted and rated for 130 volt, extended service operation.
2. All lamps that are dimmed shall be rated for 125 volt operation.
3. Where a quartz lamp equivalent exists for the specified lamp, the quartz lamp shall be furnished, unless noted otherwise.
4. All lamps that are furnished for vandal resistant fixtures, fixtures mounted near moving equipment, fixtures mounted in gymnasiums, pipe tunnels, elevator pits, and mechanical rooms shall be rated for rough service operation.
5. All lamps that are furnished for open fixtures in gymnasiums, walk-in coolers, pipe tunnels, elevator pits and fixtures above food service equipment shall be provided with a protective Teflon lamp coating to prevent the lamp from shattering.

D. Fluorescent:

1. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 3100 initial lumens (minimum), CRI 75 (minimum), color temperature 4100K, and average rated life 20,000 hours unless otherwise indicated.
2. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 4100K, and average rated life of 20,000 hours unless otherwise indicated.

3. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches, 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 4100K, and average rated life of 20,000 hours unless otherwise indicated.

4. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches, 4400 initial lumens (minimum), CRI 85 (minimum), color temperature 4100K, and average rated life of 20,000 hours unless otherwise indicated.

E. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 4100K, average rated life of 10,000 hours at three hours operation per start, unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).
7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

F. High Intensity Discharge (HID):

1. All

G. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000K.

H. Ceramic, Pulse-Start, Metal-Halide Lamps:

1. T4 Lamp
   a. 39 W and 70 W: T4, Minimum CRI 80, and color temperature 4200K.

2. T6 Lamp
   a. 39 W, 70 W, and 150 W: T6, Minimum CRI 80, and color temperature 4200K.

3. BT5 Lamp.
   a. 22 W and 39 W: BT5, Minimum CRI 85, and color temperature 3000K.

4. PAR Lamp
   a. Minimum CRI 80, and color temperature 4000K.

5. ED17 Base Lamps
   a. Minimum CRI 85, and color temperature 4000K.
6. **ED28 Base Lamps**
   
a. Minimum CRI 85, and color temperature 4200K.

### 2.2 BALLASTS

**A. Manufacturers:** Subject to compliance with the fixture manufacturer's requirements and recommendations, and the specifications included herein, provide products from the following:

1. **Electronic Fluorescent Ballast:**
   
a. Advance Transformer Company
b. Osram/Sylvania
c. Universal Lighting Technologies

2. **HID Ballast:**
   
a. Advance Transformer Company
b. Universal Lighting Technologies
c. Osram/Sylvania (pulse-start type only)

**B. General:**

1. All ballasts shall be equipped with line fusing at ampacity of the ballast and voltage ratings as required to provide overcurrent protection for the lamps and ballast. Fusing shall be type and size as recommended by the fixture manufacturer.
2. All ballasts for linear lamps shall be equipped with a linear disconnect.
3. All HID ballasts shall be equipped with line fusing at ampacity of the ballast and voltage ratings as required to provide overcurrent protection for the lamps and ballast. Fusing shall be type and size as recommended by the fixture manufacturer.
4. In indoor locations, all fluorescent ballasts serving double-ended lamps shall be equipped with a disconnecting means internal to the luminaire. The line side terminals of the disconnecting means shall be guarded. This disconnecting means shall meet the intent of National Electric Code 2008 Article 410.130 (G). Provide Sta-Kon Series LD3 Luminaire Disconnect or equivalent.
5. All fixtures of the same type shall be furnished with the same manufactured ballast type, unless specifically noted otherwise. All ballast of the same type shall be from the same manufacturer.
6. Temperatures 0 degrees F (minus 17 degrees C) and Higher: Electronic and Electromagnetic type rated for 0 degrees F, minus 17 degrees C starting temperature.
7. Temperatures Minus 20 degrees F (minus 29 degrees C) and Higher: Electromagnetic type designed for use with high-output lamps.
8. All electronic ballast for all T4 and T5 compact fluorescent lamps shall be provided with auto resetting "end-of-life" lamp protection. This protection shall be designed into the ballast to prevent catastrophic lamp failures at the lamps "end-of-life". Ballast that do not contain this protection will not be accepted. The manufacturer must provide proof of end-of-life protection in the ballast submittals.

**C. Electronic Fluorescent Ballast (Linear and Compact Types):**
1. Electronic fluorescent ballasts shall be UL listed. Ballasts shall be Class P for indoor or Type I for outdoor thermally protected and Class "A" sound rated. Fluorescent ballasts shall be rated for operation at 60 Hertz and voltage as scheduled.
2. Ballast shall be UL listed and contain non-PCB material and shall be encapsulated to ensure maximum thermal and structural integrity.
3. Electronic fluorescent ballasts for straight tube lamps shall be designed for parallel lamp operation to maintain full light output on surviving lamps if one or more lamps fail.
4. Ballast shall operate at a frequency greater than 20 kHz without any discernible flicker.
5. Ballasts shall start and operate lamps in programmable rapid start mode.
7. Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.
8. Ballast shall maintain constant light output over operating ranges of 108-132 volts on a 120-volt circuit and 250-305 volts on a 277-volt circuit. The universal input voltage ballasts will operate satisfactorily between 108 and 305 on 60 Hz supply.
9. Electronic fluorescent ballasts shall maintain the following performance:
   a. Lamp Current Crest Factor less than or equal to 1.7
   b. Total Harmonic Distortion less than or equal to 20%
   c. Power Factor greater than or equal to 0.95
   d. Ballast Factor greater than or equal to 0.88

D. HID Ballast:

1. General: Comply with ETL, CBM, ANSI C82.4 and UL 1029. Ballasts shall include the following features, unless noted otherwise:
   a. Type: Constant-wattage autotransformer or regulating high-power-factor type.
   b. Minimum Starting Temperature: Minus 22 degrees F (Minus 30 degrees C) for single lamp ballasts.
   c. Normal Ambient Operating Temperature: 104 degrees F (40 degrees C).
   d. Open-circuit operation that will not reduce average life.
   e. The ballast shall be designed with class "H" (180 degree C) or higher insulation system and shall be vacuum impregnated with 100% solid based resin.
   f. The maximum lamp current crest factor as defined by ANSI shall be less than 1.8.
   g. The ballasts shall have operating design life of 80,000 hours. The ballasts shall be designed to operate for a minimum of 180 cycles of 12 hours on and 12 hours off, with the lamp circuit in an open or short-circuited condition without reduction in ballast life.
   h. Ballasts shall be constructed using a positive means for coil and termination placement. Fiberglass or other suitable plastic wedging must be used to separate the coils from steel along the corner section of the coils. Separation must be accomplished with wedging, impregnation alone shall not be acceptable.
   i. Ballasts shall be designed to provide 90% probability of starting with 100 hour lamps at -30 degrees C.
   j. The light output shall not vary more than 11% with a plus minus 5% voltage variation in high reactance circuit and not more than 5% with a plus minus 10% voltage variation in CWA circuit. Lamp drop out voltage shall not exceed minus
25% of the rated voltage for the high reactance circuit and minus 30% for the CWA circuit.

k. Ballast shall be rated for best sound class available.

l. HID ballasts shall be rated for operation at 60 Hertz and voltage as scheduled.

m. All capacitors shall be oil filled with self-contained internal trip fault protection and bleed resistor. All capacitors shall be housed in corrosion resistant steel cans and contain .25" quick disconnect terminals. Capacitors shall not contain PCBs.

n. All ignitors shall be epoxy filled with either a plastic or aluminum external housing. The starter shall be designed to provide a minimum of 7 years of trouble-free service including 6 months of lamp open short circuit without failure.

2. Auxiliary, Instant-On, Quartz System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity discharge lamp reaches approximately 60 percent light output.

2.3 LIGHTING FIXTURES

A. Manufacturers

1. Provide lighting fixtures, of sizes, types and ratings indicated on the Drawings under the "LIGHTING FIXTURE SCHEDULE" complete with, but not limited to, housings, ballasts, starters and wiring. Design fixtures with concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen ballast generated noise.

2. The fixture manufacturer shall furnish all luminaries complete with lamps. The furnished lamps shall be recommended and tested by the fixture manufacturer to achieve optimum performance of the fixture.

3. Manufacturer catalog numbers are indicated on the "LIGHTING FIXTURE SCHEDULE" and constitute the type and quality of fixture to be provided. All published specifications of the above manufacturer that correspond to the indicated catalog number, shall be considered as part of this specification even though they may not be shown in complete detail.

4. Manufacturer's catalog numbers indicate the general line of fixtures required and may not necessarily include all prefixes and suffixes for options, trim and/or configurations required. Where a conflict occurs between the description and the catalog number, the description shall take precedence.

B. Interior Lighting Fixtures

1. Fixtures and Components, General:

a. Ship fixtures factory-assembled, complete in every respect, including all necessary parts, shown or not shown on the drawings, required for a complete installation in accordance with the manufacturer's recommendations.

b. Wiring: Provide electrical wiring within fixtures suitable for connecting to branch circuit wiring as follows:

1) NEC Type AF for 120 volt, minimum No. 18 AWG.
2) NEC Type SF-2 for 277 volt, minimum No. 18 AWG.
c. Hardware for steel and aluminum fixtures, all screws, bolts, nuts, and other fastening and latching hardware, shall be cadmium or equivalent plated. For stainless steel fixtures, all hardware shall be stainless steel. For bronze fixtures, all hardware shall be stainless steel or bronze.

d. Metal Parts: Free of burrs and sharp corners and edges.

e. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

f. Reflecting surfaces shall have minimum reflectances as follows, unless otherwise indicated:

1) White Surfaces: 90 percent.
2) Specular Surfaces: 83 percent.
3) Diffusing Specular Surfaces: 75 percent.
4) Laminated Silver Metallized Film: 90 percent.

g. Plastic Diffusers, Covers, and Globes:

1) Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a) Lens Thickness: At least 0.125 inch minimum unless different thickness is scheduled.
   b) UV stabilized.
   c) The quality of the material must meet American Society of Testing Materials (ASTM) standards and be certified by an independent test laboratory.
   d) Acrylic lenses and diffusers are cast, molded, or extruded.

2) Glass: Annealed crystal glass, unless otherwise indicated, with a transmittance of greater than 88 percent.

h. All Alzak reflectors and louvers shall be low iridescent equivalent to that produced by Coil Anodizes.

i. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

j. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

k. All recessed downlights and wallwash type fixtures shall be provided with metal trim rings. Fixtures with plastic trim rings shall not be acceptable.

l. All adjustable fixtures with beam angle or rotation adjustments shall have reliable angle locking devices.

m. All fixtures scheduled with a material, such as "brass", shall be constructed with the solid material. Plated fixtures shall not be acceptable, unless noted as finished, such as "brass finished".

n. All fixtures scheduled to be die-cast construction must be die-cast, other methods of construction, such as sand casting, shall not be acceptable.

o. Fixtures Finishes: Manufacturers' standard, unless otherwise indicated.
1) Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
2) Metallic Finish: Corrosion resistant.

2. Fluorescent and Compact Fluorescent Fixtures:
   a. Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
   b. All fluorescent troffers shall be post-painted or painted after fabrication, including ballast covers, doors, and all trim. Fixtures shall be "powder" finished with a minimum reflectance of 90%. Provide independent laboratory certification of compliance with this requirement.
   c. Fluorescent troffer lenses shall be ICI Acrylics KSH-12 lens, 0.125 inches minimum thickness, 0.080 inches minimum prism penetration, and a minimum weight of 7.8 ounces per square foot. All lenses shall be embossed with the K-Lite stamp.
   d. All troffers shall have spring-loaded cam latch doors. Fixtures without cam latches shall not be acceptable.
   e. Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
   f. All fluorescent fixtures installed in mechanical and storage spaces that have no glass or metal enclosure shall be furnished with safety type lampholders so that lamps shall not become dislodged from the holders.
   g. All open fluorescent fixtures installed near moving equipment, below 7'-0" above finished floor, and as scheduled, shall be furnished with clear plastic sleeves and end caps as manufactured by McGill, or A.L.P. Lighting and Ceiling Products, Inc.
   h. All undercounter and task lighting fixtures located under casework counters or shelves shall include various lengths of the same fixture type (series), as required to extend the entire undercounter length, unless noted otherwise.
   i. All fluorescent fixtures located in architectural coves shall include various lengths of the same fixture type (series), mounted end-to-end to fill the entire cove length, unless noted otherwise.

3. Incandescent Fixtures:
   a. Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
   b. All recessed incandescent fixtures shall be UL listed as having thermal protection. Exceptions are fixtures UL listed for and installed in poured concrete, fixtures UL listed for installation in cavities where thermal insulation will be in direct contact with the fixture, and fixtures installed in suspended lay-in, grid type ceilings that comply with UL suspended ceiling fixture listing.
   c. Provide surface mounted track with circuiting, capacity, and length as shown on Drawings. Provide track with all accessories required for a complete installation. The track shall be supplied by the same manufacturer as the fixtures specified.

4. HID Fixtures:
   a. Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
b. All recessed interior HID fixtures with integral ballasts, shall have UL listed thermal protection integral with the ballast. Exceptions are fixtures installed above suspended lay-in, grid type ceilings and that comply with UL suspended ceiling fixture listing. HID fixture ballasts shall be mounted on padded grommets to reduce noise transmission.

5. Exit Signs:
   a. Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.
   b. Internally Lighted Signs:
      1) Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum of rated lamp life.
   c. Provide universal mounting exit signs as shown, refer to location of fixture to determine if fixtures are single or double faced, and for arrow requirements. Where requirements are not clear, consult with Architect.

6. Emergency Lighting Units:
   a. General: Self-contained units complying with UL 924.
      1) Provide complete emergency battery units, including remote heads, as shown on drawings.
      2) Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty. Batteries shall operate at 12 volts, unless specified otherwise. Unit shall operate for a minimum of 90 minutes after power interruption.
      3) Charger: Fully automatic, solid-state type with sealed transfer relay.
      4) Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      5) Integral Time-Delay Relay: Holds unit on for fixed interval when power is restored after an outage; time delay permits high-intensity-discharge lamps to restrike and develop adequate output.

7. Low Voltage Fixtures:
   a. All low voltage lighting wiring shall be as recommended by the fixture manufacturer. Low voltage wiring shall be minimum #10 AWG Copper. Voltage drop shall not exceed 5% maximum. Reference the following table for 12-volt wire selection:
## 12-VOLT WIRE SELECTION TABLE

<table>
<thead>
<tr>
<th>Wire Size</th>
<th>Circuit Wattage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>#10 AWG</td>
<td>67</td>
</tr>
<tr>
<td>#8 AWG</td>
<td>107</td>
</tr>
<tr>
<td>#6 AWG</td>
<td>171</td>
</tr>
</tbody>
</table>

Wiring Distances in Feet

2.4 **FIXTURE SUPPORT COMPONENTS**

A. Comply with Division 260529 Section “Hangers and Supports for Electrical Systems” for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2 inch (13 mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2 inch (13 mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage (2.68 mm).

E. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

F. Rod Hangers: 3/16 inch (5 mm) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

H. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

I. Suspension Bars: Provide Caddy Series 517, 520 or equal from fixture manufacturer.

J. T-Bar Support Clips: Provide Caddy Series 515 or equal from fixture manufacturer.

2.5 **FIRE-RATED CEILING COVERS**

A. Where fire rated ceilings exist, provide a fire-rated enclosure over the light fixture housing above the ceiling. Fire rated enclosure shall be the Fire Protection Ceiling Cover as manufactured by Tenmat Firestop. Coordinate exact type of fire-rated enclosure in field with Architect prior to purchase.

1. The test standard for this product shall be ATSM E-119/UL 263.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Inspection

1. Examine areas and conditions under which lighting fixtures are to be installed, and substrate for supporting lighting fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to the Contractor.

2. Contractor shall consult room finish schedule on General Construction drawings for ceiling construction in each area and shall verify details thereof with ceiling installer for information as to types of lighting fixtures, hardware and mounting details necessary to mount and support lighting fixtures in each area. Where lighting fixtures are recessed into ceiling construction, Contractor shall obtain information from the ceiling installer as to the specific type of ceiling to be installed, and shall provide compatible fixtures complete with the manufacturer's recommended hardware and trim.

3. Contractor shall consult casework drawings on General Construction drawings for undercounter and task lighting fixture types and lengths, hardware and mounting details necessary to feed, mount, and support lighting fixtures in each area.

B. General

1. Install fixtures plumb, square, and level with ceiling and walls, and secure according to manufacturer's printed instructions and approved shop drawings. Install lamps in each fixture.

2. Install lighting fixtures at locations and heights as indicated, in accordance with applicable requirements of NEC, NECA's Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill project requirements.

3. Each lighting fixture shall be packaged with complete instructions and illustrations on installation. Install lighting fixtures in strict conformance with manufacturer's recommendations and instructions.

4. Install fixtures after building is enclosed, weathertight, and environmental conditions are nominally the same as expected for the completed spaces.

5. Coordinate with other electrical work as appropriate to properly interface installation of lighting fixtures with other work.

6. Luminaire Attachment: Fasten to indicated structural supports. Where possible, provide standard hold-down clips, hangers, boxes, plaster frames, extension bars, etc., supplied with the lighting fixtures, by the lighting fixture manufacturer or approved support hardware.

7. Metal decking shall not be pierced for fixture support.

8. Provide all necessary additional or auxiliary supporting steel for fixtures not mounted on building framework, and where necessary to span ceiling channels of suspended ceiling construction. Support all fixtures directly from the building structure. Do not utilize any of the following items for support.

   a. Acoustic materials.
   c. Mechanical or plumbing items or equipment.
   d. Ceiling grid system.
e. Ceiling grid system hangers.

C. Interior Lighting Fixtures

1. General

a. Recessed fixtures in suspended lay-in type grid ceilings shall have final connection of flexible metal conduit not in excess of 72 inches with THHN conductors and green wire ground conductor.
b. Install flush mounted fixtures to eliminate light leakage between fixture frame and finished surface.
c. Install plaster frames for recessed fixtures in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
d. Doors, diffusers, latches and lenses of lighting fixtures shall operate securely, smoothly and without sticking or binding to permit easy relamping. Installations that do not comply with this requirement will not be accepted.
e. Protection wrapping on parabolic fluorescent fixtures shall be removed before installation of furniture, but after interior finish work, such as painting and carpeting, is completed.
f. Provide approved fire rated enclosures around light fixtures in fire rated ceilings. Mount enclosure prior to installation of finished ceiling.
g. Installation of pendant mounted fixtures in unfinished spaces that are near obstructions such as ducts or pipes shall be suspended so the bottom of the fixture is not higher than the bottom of the obstruction. All fixtures in the space should be located at the height of the lowest fixture, but not less than 8'-0" above the finished floor, unless noted otherwise. Fixture outlets should not be located until the locations of the obstructions are determined and the outlets will be accessible after installation of other equipment.
h. Install exit signs as shown, refer to location of fixture to determine if fixtures are top, end, back, or pendant mounted, single or double face, and arrow requirements. Coordinate each location with Architect prior to rough-in. Where requirements are not clear, consult with Architect.
i. Rigidly align continuous rows of linear pendant fluorescent lighting fixtures for in-line appearance.

2. Interior Lighting Fixture Support

a. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Architect/Engineer.
b. Support for Fixtures in or on Grid-Type Suspended Ceilings:

1) Install a minimum of two ceiling support system rods or wires for each fixture from structural members. Locate not more than 6 inches (150 mm) from fixture corners.
2) Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two ¼ inch (20 mm) metal channels spanning and secured to ceiling tees.
3) Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

c. Suspended Fixture Support:

1) Support stem mounted single unit suspended fluorescent fixtures in mechanical and storage spaces with swivel stem hangers supplied by fixture manufacturer.
   
a) Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

2) Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
3) Continuous Rows: Suspend from aircraft cable.
4) Provide all pendant hangers with ball aligners and provisions for 1" minimum vertical adjustment.
5) Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   
a) Brace pendant hung fixtures in unfinished spaces that are near ducts, pipes, or other obstructions, so the fixtures do not swing into these obstructions.

6) Coordinate stem, rod, aircraft cable, or chain hanger lengths with job conditions to obtain proper mounting height of fixtures.

d. Support for surface mounted fixtures and exit signs:

1) Support fixtures directly from structural members. Provide one (1) wire hanger per fixture, minimum 12 gauge wire.
2) Support fixtures, that are centered in acoustical ceiling tile, independently with metal suspension bar spanning an electrical outlet box and clipped to the ceiling grid tees. Provide a wire hanger from box to structure.
3) Support fixtures that are aligned with ceiling grids independently, with support clips wrapped around grid. The support clip shall include a fixture stud. Provide a wire hanger from clip to structure.
4) Support surface-mounted fixtures greater than 2' in length at a point in addition to the outlet box fixture stud.

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
3.3 CONNECTIONS

A. Tighten connectors and terminals, including set screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Give advance notice of dates and times for field tests.

C. Provide instruments to make and record all demonstration test results.

D. Tests: Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source.

E. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.

F. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

G. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.

H. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards. Correct malfunctioning fixtures at the site, then retest to demonstrate compliance; otherwise, remove and replace with new fixtures and proceed with retesting.

1. Test lighting system to demonstrate capability and compliance with requirements. Demonstrate that the measured illuminance values on horizontal or vertical surface agree with the computed values submitted in illumination data.

I. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

1. IESNA LM-5-96 (Photometric Measurements – Area and Sports Lighting).
2. IESNA LM-51-93 (Electrical and Photometric Measurements of HID Lamps).
3. IESNA LM-64-91 (Photometric Measurements of Parking Areas).
4. IESNA LM-72-97 (Directional Positioning of Photometric Data).
3.5 ADJUSTING AND CLEANING

A. Clean fixtures upon completion of installation. Use methods and materials recommended by manufacturer. Lenses and louvers with dust, dirt, scratches, or fingerprints shall not be acceptable.

B. At Date of Substantial Completion replace lamps in lighting fixtures that are observed to be noticeably dimmed after Contractor's use and testing, as judged by Architect/Engineer. Replacement lamps shall be the same manufactured type as the original lamp furnished with the fixture.

1. Refer to Division 1 sections for the replacement/restoration of lamps in lighting fixtures, where used for temporary lighting prior to Date of Substantial Completion.

C. Replace defective and burned out lamps for a period of one year following the Date of Substantial Completion. Replacement lamps shall be the same manufacturer and type as the original lamps furnished with the fixture.

3.6 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.7 GROUNDING

A. Provide equipment grounding connections for all lighting fixtures. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

END OF SECTION 26 5100
SECTION 26 5561 - THEATRICAL LIGHTING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications section, apply to work of this section.
B. Division 26 Common Work Results for Electrical sections apply to work of this section.

1.2 INTENT
A. The intent of this specification is to provide for furnishing all necessary equipment, as detailed on drawings and/or schedules, for a complete stage lighting and control system.

1.3 QUALITY CONTROL
A. Equipment specified herein shall be the sole responsibility of a single vendor who shall be responsible for assuring total system operation.
B. The manufacturer shall have been producing lighting control equipment for at least ten consecutive years.
C. In order to maintain a high standard of quality and service, the manufacturer of the complete system shall also be the manufacturer of the dimmer units used in this system.

1.4 PRIOR APPROVALS
A. Prior written approval is required a minimum of ten days in advance of the bid date for alternate or substitute proposals.
B. Complete catalog data, specifications, and technical information on alternate equipment must be furnished to the Architect and Owner at least ten business days in advance of the bid date.
C. Substitutions, changes, or deletions from the plans and specifications will not be allowed without the prior written approval of the Architect or Electrical Engineer.

1.5 SCOPE
A. The work included under this specification shall cover all labor, materials, and equipment to furnish the lighting control system herein specified.
B. Shall include the services of a qualified technician supplied by the manufacturer of the system that shall check the installation and ensure its proper operation.
C. No part of the system shall be energized before being so checked and the installation approved. Failure to observe this provision shall automatically relieve the manufacturer and vendor of any responsibility concerning the proper operation of the system or any part thereof and the replacement of parts that may have been damaged by the premature energizing.

D. The lighting manufacturer shall provide an experienced representative specifically trained in standard theatrical lighting practice, which shall provide the installing contractor with the necessary information to properly install all of the lighting equipment provided. This information shall include control riser diagram, proper location and mounting of distribution equipment and lighting fixtures as well as verification of wire terminations.

E. The installing contractor shall be responsible for unpacking, lamping, and hanging all lighting fixtures in accordance with contract documents.

F. The contract price shall include all freight charges to the job site. All materials and equipment shall be packaged to protect the contents during shipment and handling and each carton shall be labeled with manufacturer's identification and the contents within.

1.6 SUBMITTALS

A. The manufacturer shall provide ten complete sets of submittal drawings for approval, prior to manufacture of any of the components per contract documents

B. All fixtures supplied shall meet or exceed the mechanical, electrical, optical, and performance data published for the equipment listed herein.

C. If required by the Architect or Engineer, the bidder shall provide at his expense, samples of proposed units for testing by an independent testing laboratory. All costs for these tests shall be the responsibility of the bidder.

D. It shall be understood that any additions or revisions of wiring required by the use of substitute equipment shall be the responsibility of the bidder making the substitution.

E. Field commissioning and instructional checkout shall be provided within 21 days of written request by the electrical contractor. A minimum of four hours of instruction shall occur the same visit as the system commissioning, and shall not exceed more than two consecutive days.

F. If the installation is not sufficiently complete to perform the checkout upon arrival of the factory engineer all costs for the additional trips shall be paid by the electrical contractor.

1.7 SHOP DRAWING SUBMITTALS AND APPROVAL REVIEW

A. Shop drawings shall be furnished for approval prior to fabrication of the equipment. A set of drawings shall be returned, appropriately marked, as the approval document.

B. When the installation is complete, the owner shall be supplied with "as built" drawings that shall be incorporated as part of the Operation and Maintenance Manual. Maintenance information shall be provided on all major units and principal components of the system.
1.8 WARRANTY

A. The manufacturer shall warrant his equipment to be free from defects in material and
d工作manship for a period two years after date of shipment from the factory or eighteen months
after the manufacturer's checkout of the installation, whichever shall occur first.

1.9 STANDARDS

A. All lighting instruments and control system components, where applicable standards have been
established shall follow the recommendations of the Underwriters' Laboratories and the
National Electrical Code, and must bear the U.L. label.

1.10 MANUFACTURERS

A. Provide products by the manufacturers indicated on the drawings and specifications. This
apparatus is fully catalogued and described with complete technical data available from the
manufacturers.

B. All of the Dimming and Control Equipment shall have one common Original Manufacturer. In
order to establish single manufacturer responsibility, no integration of more than one
manufacturer's Dimming and Control Equipment shall be allowed.

C. The listing of a manufacturer as acceptable does not imply automatic approval. It is the
responsibility of the Electrical Contractor to ensure that any price quotation and substitute meets
or exceeds the specifications herein.

D. The following manufacturers shall be permitted to bid:

1. Electronic Theatre Controls (ETC)
2. Strand
3. Leviton
4. Entertainment Technologies

PART 2 - EQUIPMENT

2.1 DIMMER RACK

A. General

1. The permanently installed, fully digital dimmer rack shall consist of up to 48 dimmer
module spaces. The dimmer racks shall be UL Listed and CSA Approved, and shall be so
labeled when delivered to job site.

B. Electrical

1. The dimmer racks shall operate at up to 120/208V, three phase, four wire + ground, 47 to
63 Hz at 800 amps max. Provisions shall be made for optional amp trap devices for fault
current protection. Standard AIC fault current protection shall be 100,000.
2. All load and neutral terminals shall accept up to a #2 AWG wire.

C. Electronics

1. Dimmer control electronics shall be contained in one plug-in Control Electronics Module. Each control electronics module shall contain no discrete wire connections, and be housed in a formed steel body with an injection-molded face panel.

D. Physical

1. The dimmer rack shall be a freestanding, deadfront switchboard, substantially framed and enclosed with 16-gauge, formed steel panels. All rack components shall be properly treated, primed and finished. Exterior surfaces shall be finished in fine texture, scratch resistant, epoxy paint. Removable top and bottom panels shall facilitate conduit termination on the 48-module rack.

2. Racks shall be designed for front access to allow back-to-back or side-by-side installation.

3. Racks shall be designed to allow easy insertion and removal of all modules without the use of tools. Supports shall be provided for precise alignment of dimmer modules into power and signal connector blocks. With modules removed, racks shall provide clear front access to all load, neutral and control terminations. Racks that require removable panels to access load, neutral or control terminations shall not be acceptable.

4. An optional bus bar kit shall be available from the factory to allow adjacent racks to be powered by a single line feed. No hard, rack-to-rack wiring shall be required. Racks that require discrete cabling to connect adjacent racks shall not be acceptable.

5. Module spaces shall be mechanically keyed to accept only the module type (20A, 50A or 100A) specified for that space. Racks that allow modules of varying wattages to plug into the same space shall not be acceptable. The rack shall be configurable to accept mixed dimmer types and sizes throughout the rack.

6. Each rack shall provide a lockable full-height door containing an integral electrostatic air filter that shall be removable for easy cleaning. A single low-noise fan shall be located at the top of each rack. The fan shall draw all intake air through the integral electrostatic air filter, over the surfaces of the module housing and out the top of the rack. The fan shall maintain the temperature of all components at proper operating levels with dimmers under full load, provided the ambient temperature of the dimmer room does not exceed 40°C/104°F. Dimmer racks that do not employ both locking doors and electrostatic air filters shall not be acceptable. The fan shall turn on whenever any dimmer in the system is activated. In the event of an over-temperature condition, only the affected dimmer module(s) shall shut down and a message shall appear on the control module LCD. The fan shall remain on during thermal shutdown of individual dimmer modules.

7. An airflow sensor shall be provided. In the event of inadequate airflow, the affected rack shall shut down until the error is corrected.

8. If the ambient room temperature drops below 0°C/32°F or rises above 40°C/104°F, a warning shall appear on the dimmer rack LCD. If the temperature rises above 46°C/115°F, the rack shall shut down until the condition is corrected.

9. A 3 x .5-inch LED status indicator (beacon) shall be mounted in the rack door. The beacon shall be visible throughout a wide viewing angle. In normal operation conditions, this LED is illuminated. If the rack's control module senses an error condition, the beacon shall flash until the error is corrected. An optional indicator shall be available for remote locations.
2.2 DIMMER RACK CONTROL MODULE

A. General

1. The dimmer rack electronics shall be contained in one plug-in Control Electronics Module. Each control module shall plug into a dimming cabinet, with no discrete wire connections. A simple user interface shall be provided for group configuration, testing and diagnostics. The control module shall be UL/cUL Listed and CE Marked.

2. The control module shall be completely digital without employing any digital-to-analog de-multiplexing schemes or analog ramping circuits.

B. Control Module Interface

1. A backlit 7-button keypad and 2-line-by-20-character backlit LCD shall be provided for configuration, preset control, status and error indication as well as diagnostics.

2. The front panel shall have four status LED indicators: a blue LED for power status and three green LEDs for Network, DMX A, and DMX B status.

C. Control Signal and Communications

1. The control module shall be provided with an Ethernet control signal input. This input shall be fully configurable with a range of patching and priority programming capabilities. The Ethernet signal shall supply seamless integration between the dimmer racks and both the entertainment and architectural lighting control systems. The Ethernet signal shall also enable remote configuration, playback, file storage and monitoring features on a personal computer on the network.

2. Two optically isolated DMX512 inputs shall also be provided, allowing overlapping or separation of any control level. 2,500V of optical isolation shall be provided between the DMX512 inputs and the electronics. Systems that do not have optical isolation on a prewired factory plug-in device shall not be acceptable.

3. A single DMX512 input may be configured as a DMX output. The DMX out shall be capable of outputting DMX from data obtained from the Ethernet.

4. The control module shall plug into an electronic backplane, with power, panic and station wiring connections available as screw terminals. DMX connections shall be available as either a screw terminal or a punch-down terminal. The Ethernet connection shall be a standard Cat5 RJ45 connection. The backplane shall also retain that specific rack’s configuration and preset data in non-volatile memory. When any new control module is inserted, it shall automatically come on-line fully functional.

5. Complete group configuration containing rack setups, preset and dimmer information shall be stored in each control module. All data shall also be transferable to and from library storage on a personal computer on a group or per-rack basis. The system shall be capable of monitoring multiple racks on a single Ethernet connection.

D. Control Module Features

1. The control module shall have a dimmer update rate better than 16ms (60HZ) or 20 ms (50 Hz) average. Dimmer outputs shall exhibit no oscillating or hunting for levels. Dimmers with the same choke type set to the same level shall output within ±1V of each other, regardless of phase or input voltage.

2. Dimmer output levels shall be regulated for incoming line voltages. The regulation shall adjust for both RMS voltage changes and deformations in the incoming AC waveform.
The control module shall monitor and adjust each dimmer's output to maintain a constant power to the load. Regulation shall maintain the desired output voltage ±1V for the entire operating range (90-240V AC) with the exception that the maximum output will be no greater than the line voltage minus dimmer insulation loss. The regulation shall compensate for dips and anomalies in the AC waveform on a dimmer-by-dimmer basis. There shall be no interaction between dimmers in the system or any other equipment. The output shall be nominally regulated to 120V, but shall be field adjustable on a dimmer-by-dimmer basis to allow for varying cable length.

3. The control module shall support a rack filled with different types and sizes of dimmer modules. The properties of each dimmer shall be configurable, including dimmer name, output curve, dimmer firing mode, and scale voltage values.

   a. The output curve selections shall include IES Modified Square, Square, Linear, and a Modified Linear output curve. The control module shall also have the capability of storing up to three custom curves as well as an adjustable preheat level, assignable on a per-dimmer basis.

   b. The dimmer firing modes shall include: Normal (Dimmed), Dimmer Doubled, Switched (unregulated on/off with adjustable on-at level), Fluorescent with adjustable threshold, and Off.

      1) Dimmers set as Dimmer Doubled shall allow a single dimmer to set two different levels on one dimmer circuit by splitting the AC power into positive and negative half cycles with no resultant DC line current.

4. The control module shall contain diagnostic routines to allow the user to test and troubleshoot the system. The control module shall also contain a Test/Bypass switch to turn all dimmers on to full for testing. This switch shall bypass all electronics and shall force the fan on.

5. The control module shall be able to record up to 128 presets group-wide. Presets shall be user programmable by recording a snapshot of current dimmer levels (as set by the all control sources), by entering dimmer levels on the control module directly, or a combination of both methods. The system shall have the ability to program and activate group-wide presets from either the control module, a console or a networked computer or handheld device. Presets shall be activated in the default fade time of 2 seconds, but shall be have a user-programmable fade time between 0 and 60 minutes.

6. In the event of data loss each rack shall maintain the last level for a user-programmable time of zero to five minutes or indefinitely, or may be programmed to fade out or to play a specific preset. Systems that do not offer this feature shall not be acceptable.

7. A system-wide panic circuit shall be provided. Any dimmer in any rack may be assigned to the panic circuit. The panic may be set as momentary or maintained, normally open or closed, and shall have an option to force all non-panic dimmers to zero.

8. DMX A and B as well as the Ethernet DMX (EDMX) data may be patched using a rack start address - assigned sequentially from a starting control channel or patched individually on a per-dimmer basis. Priority may be set per universe for the DMX inputs, and set per channel by the control source for the EDMX input. Each dimmer may have up to six network control inputs with either a highest takes precedence or priority patch. Each dimmer may also then be assigned to one of 4 rooms for additional specific preset control.

9. The control module shall provide the ability to set a dimmer, all dimmers or a range of dimmers to a level.
10. The control module shall be capable of monitoring and displaying incoming line voltage for all three phases on the LCD. With installed current sensors, the same display shall show amperage on each phase.

11. English, French, German and Spanish language support shall be standard in the control module.

12. The control module shall support 4 levels of security access. The user shall to able to program passwords that restrict access, preventing unauthorized use of higher-level functions by unauthorized personnel.

   a. Level 4: Administrator - shall have full access
   b. Level 3: Super User - shall be able to access by circuit number, change module and change rack types.
   c. Level 2: User - shall be able to access by dimmer number
   d. Level 1: Guest - shall be able to access “about” information

E. Standard Feedback:

1. System and Rack messages shall include, but not be limited to, the following:

   a. DMX port A or B has an error or has failed
   b. Network has an error or has failed
   c. Phase A, B or C is below 90 volts
   d. Phase A, B or C is above 140 volts
   e. Phase A, B or C did not start because it was below 90V or above 140V at power up
   f. Phase A, B or C voltage headroom warning
   g. Frequency is not 50 or 60 Hz
   h. Rack shutting down due to air flow loss
   i. Ambient temperature is below 0°C/32°F
   j. Ambient temperature is above 40°C/104°F
   k. Rack shutting down - ambient temperature exceeds 46°C/115°F
   l. Configuration memory error

2. About display shall allow monitoring of system, rack or dimmer status.

   a. About System shall provide information about Panic circuits, Preset looks, and System name.
   b. About Network shall provide IP address, gateway and net mask.
   c. About Rack General shall provide information about rack name, ambient temperature, air filters and rack type.
   d. About Rack Power shall provide information about power type, rack voltages, current per phase (only with current transformers), under voltage warnings.
   e. About Rack Data shall provide status for DMXA, DMXB, EDMX and Network activity.
   f. About Dimmer shall provide information about dimmer type, location, output level, control source, scale voltage, mode and curve.

F. Network Interface

1. The Ethernet network shall provide an integral link to connect all racks in the system for rack-to-rack, rack-to-console and rack-to-network device communication.
2. The network interface to the control module shall provide a number of user-programmable control logic schemes regulating the logical relationship between control sources, including architectural control.

3. A technician shall be able to program all parameters onsite, via the facepanel or using a laptop personal computer. Systems that do not provide both types of user interface shall not be acceptable. These parameters shall include, but not be limited to, defining rack type, module type, scale voltage for each dimmer, firing mode, curve, dimmer numbering and DMX512 or network port assignments. Systems requiring factory programming shall not be acceptable.

G. Web-based Interface

1. The control module shall incorporate web server technologies for interaction with standard web browsers. The Web interface shall provide an easy-to-navigate, graphical user interface for monitoring and control of the dimming systems. This interface shall duplicate all the functions of the control module.

2. The web-based interface shall be self-contained, requiring no software installation on a user’s computer. A user may use any laptop with a web browser to configure and exert basic control. A user shall be able to configure, monitor and control the dimming system using a web browser such as Internet Explorer 6.0 or higher. Use of standard web technologies shall also allow handheld computers, or PDA’s, to access and control the system. Dimming systems that do not offer this facility shall not be acceptable.

H. Physical

1. The control electronics shall be contained in one plug-in module, housed in a formed steel body with an injection-molded face panel, and self-retaining ejection handle to ease removal from the rack.

2. The control module shall operate on a universal voltage range of 90 – 250V, single- or three-phase, 47 to 63 Hz. The control module shall automatically compensate for frequency variations during operation.

2.3 DIMMER MODULES

A. General

1. Dimmer modules shall be designed for dependable, economical service in theatrical and architectural applications.

B. Electrical

1. Each dimmer module shall contain two single-pole circuit breakers, a solid-state switching module, associated toroidal filters, and power and control connectors.

2. Modules shall not have any protruding pins subject to physical damage when the module is not installed.

3. Modules shall be keyed so that dimmer modules of different capacity shall not be interchangeable.

4. Circuit breakers shall be fully magnetic so the trip current is not affected by ambient temperature. Circuit breakers shall be rated for tungsten loads having an inrush rating of no less than 20 times normal current. Circuit breakers shall be rated for 100 percent
switching duty applications. Dimmers that do not operate continuously at 100% load shall not be acceptable.

C. SCR Assembly

1. Each dimmer module shall use a solid state module (SSM) consisting of two silicon-controlled rectifiers (SCRs) in an inverse parallel configuration, and all required gating circuitry on the high voltage side of an integral, opto-coupled control voltage isolator. Rectifiers, copper leads and a ceramic substrate shall be reflow soldered to an integral heat sink for maximum heat dissipation. The SSM shall also contain a control LED, a thermistor for temperature sensing, and silver-plated control and load contacts. The entire SSM shall be sealed in a plastic housing requiring only a screwdriver to replace. Dimmers employing triac power devices, pulse transformers, or other isolating devices not providing at least 2,500V RMS isolation, shall not be acceptable. Dimmer modules requiring disassembly, heat sink grease or additional tools for repair shall not be acceptable.

2. All electronic components (current/voltage sensors and indicators) shall be contained in a single, field-replaceable housing. Modules requiring discrete wiring of electronic components shall not be acceptable.

<table>
<thead>
<tr>
<th>SCR power switching devices shall have the following minimum ratings:</th>
<th>15 A</th>
<th>20 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Size:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single cycle:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak surge current</td>
<td>625A</td>
<td>625A</td>
</tr>
<tr>
<td>Half cycle:</td>
<td></td>
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<tr>
<td>12T</td>
<td>1,620</td>
<td>1,620</td>
</tr>
<tr>
<td>Transient over voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Die size (in)</td>
<td>.257</td>
<td>.257</td>
</tr>
</tbody>
</table>

D. Filtering

1. Dimmer modules shall include toroidal filters to reduce the rate of current rise time resulting from switching the SCRs. The filter shall limit objectionable harmonics, reduce lamp filament sing and limit radio frequency interference on line and load conductors. Modules shall provide 350 uS. filter rise times. Rise time shall be measured at the worst case slew rate (about 50 percent) from 10 to 90 percent of the output wave form with the dimmer operating at full load.

2. All dimmers shall maintain their published rise time and/or fall time regardless of duty cycle or rack temperatures. Dimmers that derate due to increased dimmer temperature caused by full load operation or high phase angles shall not be acceptable.

E. Performance
1. Power efficiency for standard dimmers shall be at least 97 percent at full load with a no-load loss of 3V RMS. The dimmer shall accept hot patching of a cold incandescent load up to the full rated capacity of the dimmer.

F. Physical

1. Dimmer modules shall be fully plug-in and factory wired. Dimmer modules shall consist of a heavy duty, die-cast aluminum chassis with integral face panel. No tools shall be required for module removal and insertion. All parts shall be properly treated, primed and finished in fine-texture, scratch resistant, gray epoxy powder coat. With the exception of the circuit breaker, the module shall contain no moving parts. Each module shall be labeled with the manufacturer's name, catalog number and rating. Modules constructed of molded plastic for structural support are not equivalent and are not acceptable. Dimmer modules shall be UL Recognized.

2.4 RELAY MODULES

A. General

1. Relay modules shall be designed for dependable, economical service in theatrical and architectural applications.
2. Relay module configuration shall be dual channel, 100/140V, 15A or 20A, as noted on the Electrical Drawings.
3. Relay modules shall be fully plug-in and factory wired. The modules shall consist of a heavy duty, die-cast aluminum chassis with integral face panel. No tools shall be required for module removal and insertion. All parts shall be properly treated, primed and finished in fine-texture, scratch resistant, gray epoxy powder coat. With the exception of the circuit breaker, the module shall contain no moving parts. Each module shall be labeled with the manufacturer's name, catalog number and rating. Modules constructed of molded plastic for structural support are not equivalent and are not acceptable. Relay modules shall be UL and cUL listed power control devices with a minimum AIC rating of 10,000A.
4. Modules shall have a fully magnetic circuit breaker for each channel. Relay modules shall be rated for a minimum of 100,000 full load activations.
5. Modules shall have Signal and Load LED indicators for each channel.

2.5 WALL MOUNT RELAY PANEL

A. General

1. The wall mount relay panel shall UL Listed (UL508 FILE #E92154) and CSA Approved, and shall be so labeled when delivered.

2. The relay panel shall consist of any quantity between one and twenty-four 20 amp relays, single- or double pole as required, control electronics, sub-panel, and enclosure.

B. Mechanical
1. The relay panel shall be constructed of 16-gauge steel. All panel components shall be properly treated, primed and finished in fine-textured, scratch resistant paint. The entire unit shall surface mount.

2. Equally sized top, bottom, and side removable knockout panels shall facilitate conduit entry, with an internal pass-through plenum for side-by-side or top-to-bottom mounting. The front panel shall be easily removable as well for full front access to input, output and data connections.

3. The unit shall ship with a cover complete with a locking door, allowing controlled access to the Class 2 wiring only.

   a. Optional center-pin reject security screws shall be available for all accessible screws.

4. The panel enclosure shall be available separately from the sub-panel containing the control electronics to allow for pre-installation. The panel shall be UL Listed to be available in this configuration.

C. Thermal

   1. The panel shall be convection cooled.
   2. The panel shall operate safely in an environment having an ambient temperature between 32°F (0°C) and 104°F (45°C), and humidity between 10-90% (non-condensing).

D. Electrical

   1. The panel control electronics shall operate on single phase, two wire + ground, 120/277V AC 60Hz, at an amperage sufficient to power the panel (8 amps max). Standard fault current protection shall be 5,000 AIC.
   2. The individual relays shall be mechanically latching and capable of switching 20A at up to 300V circuits with no derating required for inductive lighting loads.
   3. Each relay shall have an integral manual override switch with on/off status indication.
   4. The relay shall have the following minimum ratings:

      a. 2000A inrush current
      b. 1500A short circuit current
      c. 5000V RMS isolation
      d. 60,000 mechanical operations

   5. The panel shall be capable of switching all relays on or off at once, or in a user-selectable delay period of 0.1 to 60 seconds, in 0.1 second increments, per relay.
   6. All line and neutral terminals shall accept up to 12 AWG wire. The control wiring shall land on a removable header for easy contractor installation (On-board DMX, SmartLink and Emergency Input terminations).
   7. A voltage barrier shall be available to separate relays carrying different voltages in the same panel. The barrier shall be capable of installation, without tools, between any two relays, and shall allow up to eight barriers per panel (4 per side).

E. Electronics

   1. The control panel on the pack shall have a power status LED indicator (Blue) and a DMX status LED indicator (Green). A 6-button menu-navigation keypad and a
two-line-by-20-character backlit LCD shall be provided for system control, configuration, and control status.

2. The panel shall receive ESTA DMX512-A control protocol. Addressing shall be set via the 6-button keypad. Any switch may be patched to any DMX channel.

3. The relays shall respond to control changes (DMX) in less than 25 milliseconds. DMX512 update speed shall be 40Hz.

4. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components.

5. The panel shall have a UL924-listed contact input for use in Emergency Lighting systems. The panel shall respond to the contact input by switching selecting relays to “on”, while switching other relays “off”. Each relay can be selected for activation upon contact input.

6. From the control panel or optional button stations, it shall be possible to record up to 32 presets. Presets shall be programmable by recording current levels (as set by DMX), by entering levels on the facepanel directly, manually selecting relay state on each relay, or a combination of both methods. Indication of an active preset shall be visible on the LCD display.

7. The presets may be recorded sequentially as a Sequence with programmable fade and hold times, which shall allow for stand-alone operation. Indication of an active sequence shall be visible on the LCD display and on optional button stations.

8. The unit shall always power-up in the last used mode and settings and shall be ready for use without user intervention. The Power Up Behavior setting shall ensure the unit restores to its previous state (preset, sequence) when power is cycled.

9. Pack setup shall be user programmable. The control panel shall provide the following setup features:

   a. Set Menu Mode - Normal or Advanced
   b. Set language - English, French, German and Spanish
   c. Adjust LCD Contrast
   d. DMX Start Address (Normal Mode) or DMX Patching (Advanced Mode)
   e. DMX Loss Behavior - Hold Last Look, Wait and Fade, Fade to Preset
   f. Individual settings for DMX “on” and DMX “off” threshold level, per relay
   g. Allow Manual - allows the manual override switch to remain in the manual position, or reset immediately to the controlled position.
   h. Station Record - allow Presets to be recorded from Station Buttons
   i. Station Master - designates which panel shall provide synchronization timing
   j. Power Up Behavior
   k. Restore Defaults

2.6 ARCHITECTURAL CONTROL PROCESSOR

A. Mechanical

1. The processor shall utilize microprocessor based, solid state technology to provide multi-scene lighting and building control.

2. ACP module electronics shall be contained in a plug-in assembly.

   a. The module shall be housed in a formed steel body and contain no discrete wire connections.
1) No tools shall be required for module removal or insertion.

3. The ACP shall be convection cooled.

4. User Interface
   a. The ACP shall utilize a backlit liquid crystal display capable of graphics and eight lines of text.
   b. The ACP shall provide an alpha-numeric keypad for data entry and navigation.
   c. The ACP shall provide a touch-sensitive control wheel for navigation.
   d. The ACP shall provide shortcut buttons to assist in navigation, selection, and data entry.
   e. The ACP keypad, buttons, and wheel shall be backlit for use in low-light conditions.
      1) The backlight shall have a user selectable time out, including no time out.

5. The ACP shall provide a front-panel RJ45 jack for Ethernet connection to the processor for configuration, live control, and web-browser-based system access.
   a. The Ethernet port shall be secured behind the locking door.

6. The ACP shall provide a Secure Digital (SD) Removable Media slot on the front panel for transfer of configuration data.
   a. The SD slot shall be secured behind the locking door.

7. The ACP shall provide a Universal Serial Bus (USB) port on the front panel for transfer of configuration data.
   a. The USB port shall be secured behind the locking door.

8. Architectural Lighting System configuration and program information shall be stored in flash memory, which does not require battery backup.
   a. The ACP shall provide a Compact Flash (CF) Card as backup flash memory and storage.
   b. The CF Card is stored in the back of the ACP, and can be accessed only by removing the ACP.
   c. The ACP data can be exchanged by inserting the CF card into another ACP.

B. Electrical

1. The ACP shall require no discrete wiring connections; all wiring shall be terminated into Dimming or Control Enclosure.
2. The ACP shall require low-voltage power supplied by the Dimming or Control enclosure.
3. The ACP shall be hot-swap capable.
4. The ACP shall support Echelon LinkPower communications with remote devices, including button stations, button/fader stations, Touchscreen stations, sensors, and third party LonMARK compliant products.
a. The LinkPower network shall utilize polarity-independent, low-voltage Class II twisted pair wiring, type Belden 8471 (unshielded) or Belden 8719 (shielded) or equivalent. One # 14 AWG drain wire will be required for system not using grounded metal conduit. Touchscreen stations, interface stations and portable stations connectors will also require (2) #16 AWG wires.
b. The LinkPower network shall be topology free. Network wiring may be bus, loop, home run, star or any combination of these.
c. Link power wiring shall permit a total wire run of 1640 ft. (500m) without a repeater. Repeater option modules shall be available to increase wiring maximums in increments of 1640 ft. (500m).
d. Link power wiring between stations shall not exceed 1313 ft. (400m).

5. The ACP shall support 10/100BaseTX, auto MDI/MDIX, 802.3af compliant Ethernet networking using TCP/IP, ESTA BSR E1.17 Advanced Control Networks (ACN) and ESTA BSR E1.31 (sACN) Protocols for internal communication and integration with third-party equipment.

6. The ACP shall support EIA-RS232 serial protocol for bi-directional command and communication with third-party equipment.

7. The ACP shall support two discrete ESTA DMX512A ports, configurable as input or output ports.*

a. *When used in a Dimming Enclosure, the second port is always an output port.

8. The ACP shall provide four onboard dry contact closure inputs for integration with third-party products.

9. The ACP shall provide four onboard contact closure outputs, rated at 1A@30VDC, for integration with third-party equipment.

C. Functional

1. Capacity

a. Shall support 1024 channels of control
b. Shall support 2 physical DMX ports, each of which may be configured as an input or output

2. System

a. Runtime application shall utilize support Net3 system interoperability
b. System shall support the use of Network Time Protocol for real time clock synchronization
c. System shall support remote firmware upload an over Ethernet connection from a connected PC running the Light Designer software or another connected processor.
d. System shall support local firmware upload from removable media (SD Card, USB Flash Drive)

3. Diagnostics

a. Shall output an Event log
b. Standard log shall store a fixed-length history of recent activity
c. Separate critical log shall only store important messages (such as boot-up settings)
4. Configuration Data
   a. Configuration Data can be uploaded over an Ethernet connection from a PC running Light Designer application
   b. Configuration Data can be retrieved from another processor
   c. A processor shall make its configuration data available for retrieval by another Processor as a backup/recovery mechanism
   d. Configuration Data shall be stored on solid-state media that can be removed to facilitate transfer between Processor units
   e. Configuration Data may be loaded to and from removable media access provided on front panel
   f. Configuration Data for the entire System shall be available for download from any single Processor
   g. Shall store configuration data for Dimming enclosure processors and shall make available for download

5. Access Controls
   a. There shall be 2 user accounts - Administrator, and User with separate password protection
   b. Account and password settings shall be local to each Processor
   c. Access Controls shall be applied to certain areas of the Local User Interface and Web Interface

6. Web User Interface
   a. Shall be an internal web server accessible via Ethernet port
   b. Shall support common web browsers on Windows and Mac platforms
   c. Shall provide functionality to Activate and Deactivate Presets
   d. Shall provide functionality to schedule timed events (add/delete)
   e. Shall display status information
   f. Shall display log files
   g. Shall allow for configuration of Processor settings (date, time)
   h. Shall allow for upload and download of configuration data
   i. There shall be links to other web-enabled devices in the System, including other Processors

7. Stations
   a. Stations shall be connected to a Processor via a LinkPower network or Ethernet
   b. Station discovery and binding shall be accomplished from the Local User Interface or Light Designer

8. Operation
   a. When contained in an dimming enclosure, a snapshot of the dimming enclosure output data shall be stored in persistent memory so that hardware can access it for immediate output on boot
   b. DMX output refresh rate shall be configurable
   c. There shall be support for 16-bit DMX Attributes
d. DMX inputs may be patched to DMX and Streaming ACN outputs as external sources

e. Streaming ACN inputs shall be patched to DMX outputs (gateway) as external sources

f. Where there are multiple external sources then priority and HTP shall be used to perform arbitration

g. External and internal sources shall be arbitrated based on user-selection of standard or custom rules

h. On Preset Record, the values of Attributes within the Preset shall be updated to reflect the current output

i. The total output may be the combination of many different Presets running concurrently

j. There shall be no hard limit on number of concurrent cross fades

k. Multiple Presets controlling the same Attribute shall first interact based on priority and second based on Latest Takes Precedence (LTP) or Highest Takes Precedence (HTP)

l. LTP and HTP operation shall be supported simultaneously and interact (at the same priority) using HTP

m. Settings due to LTP Presets may be automatically discarded from operation when overridden

n. It shall be possible to specify that a Preset or Attribute Control will persist when overridden

o. A Preset may be designated as an HTP Override and shall cause HTP values to be discarded

p. It shall be possible to modify the rate of a Preset (Cross fades, Effects) from a Control within the System

q. Each Preset shall have a status that can be Activated, Deactivated or Altered

r. Preset status may be set based on matching levels in the current output as an option

s. On startup the System shall be capable of automatically executing timed events within the previous 24 hours to synchronize its initial output state with the current time of day

9. Serial Input/Output

a. RS232 shall support 8-bit word length, parity selection and 1 or 2 stop bits

b. RS232 shall support baud rates from 4800 to 115,200 bps

c. Serial input and output messages are fully customizable

d. Serial output messages can be generated by any Control or Event

2.7 THEATRICAL LIGHTING CONTROL NETWORK

A. General

1. The theatrical lighting control network shall provide data distribution over a TCP/IP network. Data shall be layer 3 routable over the Ethernet network. Systems using proprietary formats or formats other than TCP/IP or non-layer 3 routable networks shall not be accepted.

2. Connections shall be made between consoles, facepanels, architectural processors, computers and DMX gateways over standard Ethernet distribution systems using 10/100BaseT wiring and/or 10/100BaseFL. All installations shall conform to established
Ethernet wiring practice and installation shall be performed by contractors qualified to do this type of work. All wiring shall be tested at Category 5 for full bandwidth operation to the appropriate IEEE standard.

B. Capacities

1. The network shall provide DMX routing and patching and prioritization for up to 32,767 DMX addresses and DMX data may be input or output from any port on any DMX node in the system. DMX input, routing and output shall be specifically supported on the system from multiple sources and locations up to the maximum number of nodes supported by the Ethernet topology.

2. The network shall support multiple consoles, computers, file servers, printers, and architectural processors with discrete command lines and control. The network shall support multiple venues/systems on the same network.

3. Network configuration shall be via Network Configuration Editor (NCE) software. The software shall permit complete user flexibility allowing the system operator to patch DMX data over Ethernet DMX (EDMX), assign node labels for easy identification, assign RFUs to specific systems in multi-system networks, assign DMX offsets and provide DMX port prioritization. Each node shall have a specific IP address provided automatically by the software. The user may edit this IP address. Systems that do not support simple Windows configuration or systems that do not allow complete reconfiguration of the above-mentioned features over Ethernet shall not be acceptable.

4. All configuration data for each network device shall be held at the device and system operation shall not require continuous on line operation of the network configuration software.

5. Architectural and Entertainment systems connected to the same network shall be capable of arbitrating control over EDMX data. The system shall be capable of alternating control of individual dimmer data between architectural and entertainment systems without intervention by the user. The user shall dictate the conditions under which the system shall automatically take control and the network shall allow user override of the user selected defaults. Systems which require direct user intervention to allocate control of dimmers between architectural and entertainment lighting systems shall not be allowed.

6. The network shall allow multiple DMX inputs assigned to the same EDMX range to be set at different priorities. This shall allow the user to assign high or low priority to each DMX input port in the network on a port by port basis. The network shall require a valid DMX signal present at the input to initiate prioritization. Systems that do not allow for prioritization shall not be allowed.

C. Operational Features

1. Each two-port DMX Node shall control up to 1024 DMX addresses, within the confines of up to 64 DMX (32,767 EDMX address) “universes”. The specific DMX data input or output by the Node shall be freely configurable by the user. Duplicate outputs of DMX lines (DMX splitter) and discrete outputs shall be fully supported.

2. Any number of DMX universes may be configured with any length up to 512 addresses as long as the total does not exceed 32,767. Any range of DMX addresses may be selected for each. Multiple sources may be combined and a priority may be assigned to each source. Each DMX line may have its own start address and offset for ease of use.
3. DMX ports shall be configurable for either input or output. Multiple DMX signal routing patches and multiple facilities shall be specifically supported and limited only by the file storage capacity of the computer with Network Configuration Editor software installed.
4. File transmission, synchronization, and access to File Servers using Microsoft NT server software shall be supported.
5. All Network configuration information shall be available as a system printout.

2.8 LIGHTING CONSOLE AND ACCESSORIES

A. General

1. The lighting control console shall be a microprocessor-based system specifically designed to provide complete control of stage, studio, and entertainment lighting systems.
2. The control system shall also be able to control third party ACN devices directly. The system shall provide control of 1000 outputs/channels, 1500 outputs/channels or 2000 outputs/channels.
3. A maximum of 10,000 cues, 99 cue lists, 1000 groups, 1000 presets, 4 x 1000 palettes (Intensity, Focus, Color and Beam), 1000 effects, 1000 macros and 99 curves may be contained in non-volatile electronic memory and stored to an onboard hard disk or to any USB storage device.
4. The console may be placed in Tracking or Cue Only mode by the user as a system default and overridden on individual record actions as required.
5. A Master Playback fader pair and dedicated Grand Master/Blackout shall be provided.
6. Up to six USB fader wings may be connected to the console, for a maximum of 240 submasters and or 30 playback faders, with six pages of control. USB fader wings may be rigidly connected to the main console to provide a "single connected unit" with no external cables required. The wings also may be connected via USB cables and used "on the side."
7. A high-resolution level wheel shall be provided to control intensity for selected channels and scrolling within selected displays. Four page-able high-resolution encoders shall be provided for control of other non-intensity parameters. Non-intensity parameters shall be controllable via the encoders or keypad controls, without need of an external pointing device.
8. Rotary encoders for non-intensity parameters shall be labeled by means of an integral LCD display mounted above or below the encoders on the main console. The display shall show the currently loaded functions of the encoders based on the current selections. Systems using encoders with no LCD labeling shall not be acceptable.
9. Control and programming features for automated fixtures shall also include: a standard library of fixture profiles, the ability to edit existing profiles and create new profiles, patch displays including channel and output addressing, 16-bit fade resolution, color characterization allowing color mixing and storing in Hue and Saturation or native device values.
10. System information, including playback status, live output and blind values for all record targets shall be displayed on a maximum of two external high resolution DVI monitors, or one SVGA monitor, which may also be touch-screen(s). Only one display shall be required for operation.
11. The system shall direct user input through on-screen dynamic prompts and integral LEDs on console keys indicating current operating mode. A context sensitive on-line Help feature shall explain and provide an example of the operation of each feature of the system.
12. An optional, fully-functioning, detachable alphanumeric keyboard shall be provided. The keyboard shall allow labeling of channels, cues, presets, groups, palettes, effects, macros, curves and the show. An integral electronic keyboard shall be provided.

13. A row of softkeys shall be provided, which change function based on the selection and context of the console. These softkeys shall be labeled via an adjacent LCD display that shows their current functions at all times. Systems using softkeys with no LCD display shall not be acceptable.

14. Console software upgrades shall be made by the user via a USB port; changing internal components shall not be required.

15. The console operating software shall be loaded into program execution memory from the internal hard drive when the console is powered. In the event of an uncontrolled shutdown, the console shall return to its last output state when power is restored.

16. Show data may be created and modified on a personal computer, using an offline editing application.

17. A PC running a client software application shall be able to connect to a control system via the network and view or modify current show data in an independent display environment. Additional devices on the network shall also be able to act as clients to the main console.

18. Synchronized backup shall be provided via another full console on the network or by use of a remote processor unit. The backup unit (either full console or rack mounted Remote Processor Unit (RPU)) shall maintain synchronized playback with the master and shall take over control of the lighting system upon loss of communication with the master. Use of two RPUs to service and backup system output is also supported. Systems that do not offer this kind of instant backup from multiple sources shall not be acceptable.

19. A maximum of four users may access and interact with show data simultaneously. Each user shall have an individual workspace.

20. The system shall allow remote control from external devices as follows: Client software running on a PC connected to the network, a remote video interface with keyboard, a purpose-built wireless remote focus unit (Radio Focus Remote). Universal fader wings may be attached to any of these devices for local fader control. Systems without these remote control devices shall not be acceptable.

21. The system shall support up to 32 individual Time Code Event lists.

B. Controls and Playback

1. Manual Control and Programming Section

   a. The console keyboard shall be grouped by function. Major groupings shall be record target functions, numeric keys, level assignment functions, display navigation functions, and controls.

   b. Non-intensity parameters may be set numerically or via the encoders. This control shall be fully interactive. In either case the current parameter value shall be displayed on the console monitor and simultaneously on the console LCD display. Systems using only a local LCD or only a video monitor shall not be acceptable.

   c. Only those parameters available for control in the active lighting system shall be displayed for control.

   d. Fixture controls provide direct access to luminaire functions such as striking and dousing arc lamps and calibrating entire fixtures or individual mechanisms of fixtures, as provided by the luminaire manufacturer. User access to these features is normalized across all manufacturers for ease of use. Use of a “control channel” for accessing these functions shall not be required.
e. Fixtures with CMY or RBG color mixing may be set with direct CMY or RBG controls, as well as the Hue and Saturation encoders and/or color picker. Color may also be set directly to a gel match, normalized to 3200 °K.

2. Playback Section
   a. The master fader shall consist of a 60mm Master Fader pair with associated Load, Go and Stop/Back buttons. Additional playback faders may be configured via the virtual fader module or on the Universal Fader Wings.
   b. It shall be possible to instantaneously halt an active cue, back to the previous cue, manually override the intensity fade or manually override the entire fade.

3. Fader Wings
   a. Submaster and fader support shall be provided via optional fader wings. These wings are available in 1x20, 2x10 and 2x20 configurations. Up to six of these wings may be connected to the desk via internal or external USB. Six pages of control are supported.
   b. The 2x10 and 2x20 fader wings shall include a full length LCD for labeling and identification functions. Each fader shall have two associated hard buttons for various operations. Systems without a local display or fewer than two buttons per fader shall not be acceptable.
   c. Up to 240 proportional, fully overlapping additive or inhibitive submasters may be defined. Submasters shall have colored LEDs to indicate submaster status. Each submaster may have fade up, dwell and down fade times. Each has a bump and solo button. Submasters may be set to independent.
   d. The submaster blind buffer shall be linked directly to live playback allowing live editing of live submaster content via the command line.
   e. It shall be possible to set submaster values directly from the command line.
   f. Up to 30 cue lists may be active concurrently.

4. Grand Master
   a. A dedicated grand master and blackout button are provided.
   b. The grand master shall proportionally fade intensity values to zero. Blackout shall send all intensity outputs to zero. Non-intensity outputs shall not be affected. No additional configuration shall be required to withhold non-intensity values from Grand Master and Blackout control.

C. Display Controls
   1. Format shall change the view of selected displays.
   2. It shall be possible for the user to choose which parameter categories or parameters (s)he wishes to display.
   3. Flexichannel shall change which channels are viewed in selected displays, based on a variety of different criteria.
   4. Expand shall extend the selected view sequentially across connected displays.
   5. Time shall display discrete timing data.
   6. Data shall display absolute values of referenced data.

D. Operating Modes
1. Live Mode

a. Channel lists may be constructed using the +, - and Thru keys.
b. Levels may be set with the keypad, level wheel and non-intensity encoders. “Selected” channels shall be those last addressed and under keypad control.
c. Sneak shall be used to restore specified channels to background states, default values, or to send them to specified values, in user specified or default times.
d. Selected channels may be set at a level or held to current values while all other channels are set to zero using Rem Dim. Toggling Rem Dim shall restore all unselected channels to original levels.
e. Channels may be recorded into groups for fast recall of commonly used channels. 1000 groups shall be available. Groups shall store selection order. The Offset function supports rapid creation of ordered groups, including reverse and random order.
f. Parameter settings may be stored to Intensity, Focus, Color and Beam Palettes and to Presets. All referenced data may be stored to whole numbers or to up to 99 decimal places between each whole number. It shall be possible to store 1000 presets and 1000 of each palette type.
g. Any collection of channel data, as determined by the use of “Record”, “Record Only”, selective store commands and/or parameter filters may be stored to palettes (as appropriate to the type) and presets.
h. The following conditions may be placed on a channel or channel parameter to be included with a cue record action.

1) Discrete fade time and/or delay
2) Block flag
3) Assert flag
4) Note

i. Cues may be recorded in any order. Up to 99 decimal cues may be inserted between any two whole number cues. Each cue may contain a maximum of twenty parts. Parameters may be automatically assigned to specific parts or assigned when the part is created.

j. It shall be possible to record cues and cue parts with the following information:

1) Any collection of channel data, as determined by the use of “Record”, “Record Only” or selective store commands, combined with parameter filters.
2) Cue Level timing and delays for Intensity Up, Intensity Down, Focus, Color and Beam.
3) Follow or hang time
4) Link instruction
5) Loop value
6) Intensity Hold
7) Block and/or Mark Flag
8) Curve
9) Label and note
10) Execute list to trigger other activity
k. Non-intensity channel parameters may be marked (preset), in two ways. Automark presets any parameters transitions in the cue just prior to intensity becoming active. Automark may be disabled on a cue or cue part basis, enabling a “live” move. Alternatively, non-intensity parameters may be marked to a specific cue with a single command instruction. It shall not be necessary to store these parameters directly into the cue in which the movement is to occur.

l. Any channel parameter may be stored with an effect instruction. These effects may contain relative offsets from current value, or absolute instructions. Effects may be progressive action or on/off states. Entry and exit behaviors shall modify the channel parameters activity when beginning and ending the effect.

m. Update may be used to selectively add modified parameter data quickly to that parameter’s current source. It shall be possible to update inactive record targets. It shall also be possible to update back to the current source of the move instruction without specifying that cue via Trace.

n. Recall From quickly pulls specified data from record targets into the current view.

o. Copy To quickly copies selected data to specified record targets.

p. Address and channel check functions shall be provided.

q. Channel parameters may be “parked” at levels. Output addresses may also be parted directly. Parked levels shall not be added to any live record operations, nor may they be changed until the parked element is “unparked”.

r. About shall provide detailed status of selected channels or specified record targets, including utilization information. About shall also access lamp control functions to calibrate devices, strike and douse arc sources. Use of a luminaire control channel for these functions shall not be acceptable.

s. Live data may be displayed in a summary view or detailed table orientation.

t. Undo shall be used to sequentially step back through manual operations, record, update and delete actions. Redo functions shall be provided.

u. Home shall set selected channels non-intensity parameters to their default values.

v. Move shall allow all show data to moved from one record target to another.

2. Blind

2a. The Blind display allows viewing and modification of all record targets without affecting stage levels.

2b. Record target data may be displayed in a summary view, a detailed table orientation or a spreadsheet view, which allows quick data comparisons, move and replace with functions.

2c. Changes made in blind displays show be automatically stored.

2d. Blind editing shall be possible for all record targets.

2e. Selection of what parameter data to view for blind editing shall be user configurable.

3. Patch Display

3a. Patch shall be used to display and modify the system control channels with their associated library data.

3b. Each channel may be provided with a proportional patch level, preheat, curve, label, swap and invert functions.

3c. Offset functions in patch shall allow selection of channel ranges and shall allow the user to establish a “custom” footprint for any device output.
d. Custom color wheels, color scrolls and gobo wheels shall be defined in patch. These devices shall be created with a simple table and graphical user interface supported by images of major manufacturers.
e. Copy to and Move functions shall be supported in patch.

4. Setup/Browser
   
a. Setup shall access system, show and desk configurations.
b. The browser shall access show data storage, import, export, print and clear functions, as well as show data utilities.

E. Interface Options
   
1. The console shall support a variety of local interfaces.
   
a. AC input.
b. USB (five ports for connecting devices such as a Alphanumeric keyboard, mouse, touch screens, USB Flash drive, fader wings, etc.) The desk shall provide four ports on the rear of the console and one on the control service itself.
c. Ethernet (one port) 802.3af compliant.
d. One Dual DVI video output connector, supporting a maximum of two DVI monitors at 1280x1024 resolution minimum.
e. One VGA output connector.
f. Up to six fader wings may be attached to the main console via internal or external USB connections. Systems that do not allow the addition of fader wings shall not be acceptable.

F. Physical
   
1. All operator controls and console electronics for a standard system shall be housed in a single desktop console, not to exceed 19” wide, 19” deep, 5.5” high, weighing 20 pounds. Consoles that will not fit in a 19” rack shall not be acceptable.
2. Console power shall be 95 – 240V AC at 50 or 60Hz, supplied via a detachable power cord.

G. Provide the following lighting control console accessories:
   
1. (2) 17” Flat Panel LCD Monitors
2. (1) Console Littlite
3. (1) 15’ Ethernet Cable
4. (1) 15’ DMX Cable

2.9 DATA PLUG-IN STATIONS

A. General
   
1. The Plug-in Stations shall consist of the appropriate connectors required for the system in use. These stations shall be available with various input and output control connections.
B. Physical

1. Station faceplates shall be .80” aluminum, finished in fine texture, scratch-resistant black powder coat. Silk-screened graphics shall be white.
2. The station panel shall mount into an industry standard back box, depending on size and quantity of connectors. A terminal block shall be supplied for contractor terminations.

C. Provide data plug-in stations as shown on the drawings

2.10 CONTROL EQUIPMENT RACK

A. An appropriately sized equipment rack as manufactured by Middle Atlantic products shall be provided. Equipment rack contents shall be as shown on the drawings.

2.11 CONTROL STATIONS

A. Button Stations

1. Mechanical
   a. Button stations shall operate using up to ten programmable buttons.
   b. All button stations shall be available with white, cream, ivory, gray or black faceplates, and buttons.
      1) Manufacturer's standard colors shall conform to the RAL CLASSIC Standard.
   c. Stations shall have indicators lights at each button or fader.
      1) Indicators shall be comprised of red, green and blue LED's
      2) Indicator color and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.
   d. All faceplates shall be designed for flush or surface mounting.
   e. Station faceplates shall be constructed of ABS plastic and shall use no visible means of attachment.
   f. Station faceplates shall be indelibly marked for each button or fader function.
   g. The manufacturer shall supply back boxes for flush mounted half gang stations and for all surface mounted stations.
   h. All Button and Button/Fader stations shall be designed to accept the infrared signal from a remote hand held IR transmitter.
      1) The stations shall have a 60° reception angle and shall operate reliably within a 45' distance.
   i. IR Transmitters shall be available in seven or twelve button configurations. Custom transmitters may have up to 10 programmable buttons.
1) IR transmitters shall be mounted in a hand-held black plastic controller. Transmitter dimensions shall be 1.875” wide, 6.625” long and 0.60” deep.

2. Electrical

   a. Control station wiring shall be an Echelon® Link power network.

      1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).

      2) Touchscreen and Interface stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.

      3) Network wiring may be bus, loop, home run, star or any combination of these.

      4) Network insulation displacement connectors shall be provided with all stations.

3. Functional

   a. The Control System shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.

      1) System presets shall be programmable via Button, Button/Fader, Touchscreen, or programming software.

         a) Presets shall have a discrete fade time, programmable from zero to 1,000 hours with a resolution of one millisecond.

         b) Presets shall be selectable via button, fader, IR transmitter, time clock event, macro activation or switch interface stations.

      2) System macros and sequences shall be programmable via system software.

         a) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.

         b) Macro and sequences shall be activated by button, time clock event or software.

      3) System time clock events shall be programmable via system software, the processor user interface, or the internal web server.

         a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.

         b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.
b. Station Button, Button/Fader, and Interface) control components shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via a Windows-based configuration program.

1) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, cue light, or room join/separate.
2) Optional fader functions include manual master control, individual zone control, fade rate control or preset master control.

c. Stations (Button and Button/Fader) shall allow programming of station and component electronic lockout levels via software.

B. Provide control stations as shown on the drawings

2.12 TOUCHSCREEN CONTROL STATIONS

A. General

1. Touchscreen stations shall support default and fully graphical control pages.
2. The Touchscreen station shall operate using graphic buttons, faders and other images on at least 30 separate programmable control pages.
3. Touchscreen stations shall also allow programming of page pass-code, lock out and visibility levels.

B. Mechanical

1. Touchscreen stations shall consist of a seven inch, backlit liquid crystal display (LCD) with a minimum resolution of 800 by 400 pixels and 12-bit color depth with a touch interface.
2. Touchscreen bezels shall be constructed of aluminum and shall have no visible means of attachment.
   a. The bezel shall install and remove without the use of tools.
   b. The bezel shall provide two working positions for the Touchscreen: service and operating.
3. The Touchscreen shall have a protective overlay over the display.
   a. The overlay shall reduce wear
   b. The overlay shall reduce glare
4. The manufacturer shall provide backboxes for all LCD stations.

C. Electrical

1. Touchscreens shall be powered entirely by the System network.
2. Touchscreens shall connect to the System using an Ethernet network with Power over Ethernet (PoE) or the control station Echelon® Link power network.
   a. Ethernet Network
1) Ethernet network shall be 10/100BaseTX, auto MDI/MDIX, 802.3af compliant.
2) Network shall utilize Unshielded Twisted Pair (UTP) Category 5 wiring.

b. Echelon® Link power network.

1) Link power shall utilize low-voltage Class II unshielded twisted pair, type Belden 8471 or equivalent, and one #14 ESD drain wire (when not installed in grounded metal conduit).
2) Touchscreen stations shall also require (2) #16 AWG stranded wires for 24Vdc operating power. 24Vdc wiring shall be topology free.
3) Network wiring may be bus, loop, home run, star or any combination of these.
4) Network insulation displacement connectors shall be provided with all stations.

D. Functional

1. System
   a. The Touchscreen shall support configuration firmware upload from a processor as proxy
   b. The Touchscreen shall support configuration or firmware upload from local removable media

2. Setup Mode
   a. There shall be a setup display that is separate from any user-defined configuration
   b. It shall be possible to view and modify connectivity settings
   c. It shall be possible to view status information
   d. It shall be possible to view and modify LCD screen settings
   e. It shall be possible to perform Touchscreen calibration
   f. It shall be possible to view and modify audio settings
   g. The appearance of the setup display shall be standard and not editable
   h. The setup display may be invoked from within the user-defined configuration and/or physical button on the Touchscreen
   i. There shall be a default protected method to invoke the setup display

3. Configurations
   a. It shall be possible to have multiple configurations stored within an LCD Station
   b. Only one configuration may be active on the LCD Station
   c. It shall be possible for Touchscreen Stations connected via the Echelon® Link power network to select a configuration automatically based on the configuration of the physical connection.
   d. Where multiple configurations are stored there shall be a boot menu to allow selection of a configuration
   e. Each configuration shall be identified as a different Station within the System

4. Operation
a. The control system shall be designed to allow control of lighting and associated systems via Touchscreen controls. System shall allow the control of presets, sequences, macros, and time clock events.

1) System presets shall be programmable via Button, Button/Fader, Touchscreen, or software.
   a) Presets shall have a discrete fade time, programmable from zero to 84,600 seconds with a resolution of one hundred milliseconds.
   b) Presets shall be selectable via Touchscreen stations.

2) System macros and sequences shall be programmable via system software.
   a) Macro and sequence steps shall provide user selectable steps, and allow the application of conditional logic.
   b) Macro and sequences shall be activated by button, time clock event or software.

3) System time clock events shall be programmable via the Touchscreen, system software, the processor user interface, or the internal web server.
   a) Time clock events shall be assigned to system day types. Standard day types include: anyway, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday. System shall support programming of additional custom or special day types.
   b) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event. System shall automatically compensate for regions using a fully configurable daylight saving time.

b. Touchscreen stations shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via a Windows-based configuration program.

1) Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, and cue light, or room join/separate.

2) Optional fader functions include master control, individual channel control, fade rate control, or preset master control.

c. Touchscreen stations shall allow programming of station and component electronic lockout levels via software.

d. It shall be possible to adjust LCD contrast and brightness.

e. It shall be possible to program the station to dim during periods of inactivity.

E. Provide touchscreen LCD control stations as shown on the drawings

2.13 POWER DISTRIBUTION EQUIPMENT

A. General
1. Connectors shall be 20A twist lock. Internal wiring shall be sized to circuit ampacity and shall be rated at 125°C.
2. Terminations shall be at one end using feed through terminals individually labeled with corresponding circuit numbers. 20 amp circuits shall use screwless tension clamp terminals listed for 20 – 8 gauge wire. Terminals that place a screw directly on the wire are not acceptable.
3. Equipment, except for wall-mounted boxes, shall be supplied with appropriate brackets and hardware for mounting as shown on the drawings. Connector strips shall have brackets on 5’ centers. Brackets shall be 1½” x .188” ASTM A 36 steel and hardware shall be ASTM A307 grade 5.
4. Power distribution equipment shall be Underwriter Laboratories (UL) Listed.

B. Connector Strips

1. Connector Strips shall be fabricated from 18 gauge galvanized steel 6.25”H x 3.3”D with length specified in increments of 6” and shipped fully wired in a minimum of 6’0” sections with all splicing hardware included. They shall be finished with fine-textured, scratch-resistant, black powder coat. Circuits shall be labeled on one side of the connector strip with 2” white lettering on black background labels. Outlets shall be spaced on 18” centers, or as otherwise specified. Outlets shall be mounted on individual 3” panels and there shall be no external terminal boxes for units with 28 or fewer circuits unless otherwise specified.

   a. Connector strip circuit numbers shall be labeled in the following manner:

      1) Circuits shall be labeled on one side of the connector strip with 2” white lettering on black background labels.

C. Prior to the fabrication of the connector strips, the contractor shall field verify the measurements of the existing strips and the new strips shall be manufactured to match.

D. Outlet and Pigtail Boxes

1. Outlet and Pigtail Boxes shall be fabricated from 18-gauge cold rolled steel with 16 gauge covers. They shall be finished with fine-textured, scratch-resistant, black powder coat. Circuit numbers shall be 2” or ½” labels with white letters on black background (sized to match product). Pigtails and outlets shall be spaced on 3” centers, or as otherwise specified.

E. Provide connector strips and outlet boxes as shown on the drawings.

2.14 THEATRICAL LIGHTING FIXTURES – GENERAL REQUIREMENTS

A. All stage lighting fixtures (excluding automated lights and followspots) shall include the following:

   1. c-clamp
   2. safety cable
   3. color frame
   4. installed stage pin connector
5. lamp(s) as specified

2.15 ELLIPSOIDAL SPOTLIGHTS

A. Physical

1. The unit shall be constructed of rugged, die cast aluminum, free of burrs and pits, finished in black or white, high temperature epoxy paint. Tools shall not be required for either lamp alignment or cleaning the reflector or lens.

2. The following shall be provided:

   a. Integral cable clamp for power leads
   b. Positive locking of lamp focus and independent lamp alignment controls
   c. High impact, thermally insulated knobs and shutter handles
   d. Reflector secured with shock mounts
   e. Lens secured with silicone shock mounts
   f. Rotating shutter assembly - 50° rotation
   g. 20 gauge stainless steel shutters
   h. Insulated rear handle
   i. Interchangeable lens tubes for different field angles with Teflon guides for smooth tube movement
   j. Sturdy integral die cast gel frame holders with two accessory slots, and a top mounted, quick release gel frame retainer
   k. Rugged 3/16” x 1-1/4” steel yoke with two mounting positions allowing 300°+ rotation of the fixture within the yoke
   l. Positive locking, hand operated yoke clutch
   m. Slot with sliding cover for motorized pattern devices or optional iris

B. Optical

1. The optical train shall combine a compact filament lamp with a precision molded borosilicate, ellipsoidal reflector and aspheric lens to produce an optimum cosine field.

2. The unit shall provide, but not be limited to:

   a. Molded borosilicate reflector with multiple dichroic layers
   b. 95% of visible light shall be reflected while 90% of infrared light as heat shall be transmitted through the reflector
   c. Low gate and beam temperature
   d. Sharp imaging through a three plane shutter design
   e. Projector-quality, high contrast aspheric lens, with an anti-reflective coating to increase transmission

C. Performance

1. The unit shall be precision engineered to use an HPL lamp to deliver an even, intense field with cosine distribution.

2. The unit shall provide, but not be limited to:

   a. 5, 10, 14, 19, 26, 36, 50, 70 and 90 degree field angles
   b. Projector-quality pattern imaging
c. Sharp shutter cuts without halation

d. Shutter warping and burnout in normal use shall be unacceptable

e. Adjustable hard and soft beam edges

3. The unit shall be UL and cUL listed and so labeled.

D. Lamp

1. The high efficiency lamp shall be an HPL lamp, which shall consist of a compact tungsten filament contained in a krypton-filled quartz envelope. The lamp shall mount axially within the reflector. The lamp base shall have an integral die cast aluminum heat sink that reduces seal temperature and ensures proper lamp alignment. The lamp socket shall be ATP 220 nickel gold plated.

2.16 ELLIPSOIDAL ZOOM SPOTLIGHTS

A. Physical

1. The unit shall be constructed of rugged, die cast aluminum and extruded aluminum, free of burrs and pits, finished in black, high temperature epoxy paint. Tools shall not be required for either lamp alignment. A Phillips head screwdriver shall be required for cleaning the reflector.

2. The following shall be provided:

   a. 15° -30° or 25° - 50° field angle range
   b. Bind free one hand zoom angle/focus adjustment and locking dial with field angle indicators
   c. Scale markings on lens tube
   d. Insulated rear handle
   e. Double clutch fixture body for both 15° - 30° and 25° - 50° version
   f. Integral cable clamp for power leads
   g. Positive locking of lamp focus and independent lamp alignment controls unaffected by relamping
   h. High impact, thermally insulated knobs and shutter handles
   i. Reflector secured with shock mounts
   j. Rotating shutter assembly - 50° rotation
   k. 20 gauge stainless steel shutters
   l. Interchangeable / retrofitable rotating lens tube
   m. Lens tube door for easy access to lenses
   n. Sturdy gel frame holders with two accessory slots, and a top mounted, quick release electroplated black gel frame retainer
   o. Rugged 3/16” x 1-1/4” (4.8mm x 31.8mm) steel yoke with two mounting positions allowing 300°+ rotation of the fixture within the yoke for 25° - 50° version
   p. Positive locking, hand operated yoke clutch
   q. Slot with sliding cover for motorized pattern devices or optional iris

B. Optical
1. The optical train shall combine a compact filament lamp with a precision molded borosilicate ellipsoidal reflector and dual Anti-reflection coated precision aspheric lens system to produce a highly efficient optimum cosine field and sharp pattern projection.

2. The unit shall provide, but not be limited to:
   a. Molded borosilicate reflector with multiple dichroic layers
   b. 95% of visible light shall be reflected while 90% of infrared light as heat shall be transmitted through the reflector and removed from the projected beam.
   c. Low gate and beam temperature
   d. Sharp imaging through a three plane shutter design
   e. For the 15° - 30° Zoom – Two Bi-convex aspheric lenses with an anti-reflective coating to increase lens transmission
   f. For the 25° - 50° Zoom - a plano-convex aspheric front lens with an anti-reflective coating and a Bi-convex aspheric rear lens with an anti-reflective coating to increase lens transmission

C. Performance

1. The unit shall be precision engineered to use an HPL lamp to deliver an even, intense field with cosine distribution. Nominal field angle cosine field lumen output shall be at least 7680 lumens for 15° - 30° version and 9060 lumens for 25° - 50° version.

2. The unit shall provide, but not be limited to:
   a. 15° - 30° or 25° - 50° field angle range
   b. Smooth, easy lens movement and single hand adjustment for simultaneous field angle and focus setting.
   c. Projector-quality pattern imaging (stainless steel, glass, and rotating patterns)
   d. °Sharp shutter cuts without halation
   e. Shutter warping and burnout in normal use shall be unacceptable
   f. Adjustable hard and soft beam edges

3. The unit shall be UL/cUL listed and so labeled.

D. Lamps

1. The high efficiency lamps shall be an HPL lamp, which shall consist of a compact tungsten filament contained in a krypton-filled quartz envelope. The lamp shall mount axially within the reflector. The lamp base shall have an integral die cast aluminum heat sink that reduces seal temperature and ensures proper lamp alignment. The lamp socket shall be ATP 220 nickel gold plated.

2.17 VARIABLE FOCUS SPOTLIGHT

A. Physical

1. The spotlights are constructed of rugged, die cast aluminum, free of burrs and pits, finished in black, high temperature epoxy paint.

2. The spotlight shall provide, but not be limited to:
   a. Rugged die-cast aluminum construction
b. Ten interior baffles to eliminate beam scattering and spill light.
c. Thermally insulated, precision focus knob.
d. A sealed reflector housing that shall prevent all light leaks.
e. 17 heat-sink fins cast into the reflector housing for temperature control.
f. Integral cable clamp for power leads.
g. A brass self-retaining screw to retain the lamp socket.
h. Sturdy gel frame holders with two accessory slots and a top mounted, quick release gel frame retainer.
i. Rugged steel yoke with 300°+ rotation of fixture within yoke.
j. Positive locking, hand operated yoke clutch.

3. Unit shall be nominally 11” long by 10” wide.
4. Unit shall not weigh more than 8.5 pounds (without c-clamp).
5. The spotlight shall be UL and cUL listed and so labeled.

B. Electrical

1. The unit shall have an operating range of 115-240V, 50/60Hz.
2. The unit shall be capable of using a maximum of 750W HPL lamp.
3. The three conductor, 36” leads shall be rated for high temperature and encased in a glass fiber outer sleeve.

C. Lamp

1. The instrument shall use only one lamp type, the HPL lamp.
2. Fixtures that require the purchasing of multiple lamp types to achieve different field angles shall not be acceptable.
3. The lamp shall:
   a. Be an HPL lamp consisting of a compact tungsten filament, contained in a krypton-filled quartz envelope.
   b. Mount axially within the reflector and shall be pre-focused within the reflector.
   c. Have an integral die cast aluminum heat sink that reduces seal temperature and ensures proper lamp alignment.
   d. Use an ATP 220 nickel gold plated socket.

D. Lenses

1. Lens sets shall consist of two patented wave lenses. One clear and one stippled.
   a. Lenses shall be heat resistant, borosilicate glass.
   b. Beam orientation of 25°-45° (spot to flood) shall be possible through rotation of exterior rotation knob connected to a rotatable collar housed in the front of the unit.
   c. Fixtures which require user to reposition the lamp socket to change the beam angle shall not be acceptable.

E. Optical

1. The optical train shall combine a compact filament lamp with modified parabolic and multifaceted reflector.
2. Reflector finish shall be an Enhanced Aluminum deposition.
3. Reflector shall be cast into a heat sink assembly.
4. Reflector efficiency shall be a minimum of 93%.
5. Reflectors of pressed aluminum sheet construction shall not be acceptable.

2.18 PAR SPOTLIGHT

A. Lamp

1. The instrument shall utilize an HPL lamp, which shall consist of a compact tungsten filament contained in a krypton-filled quartz envelope.
2. The lamp shall mount axially within the reflector and shall be prefocused within the reflector.
3. The lamp base shall have an integral die cast aluminum heat sink that reduces seal temperature and ensures proper lamp alignment.
4. The lamp socket shall be ATP 220 nickel gold plated.
5. All versions of the instrument shall use only one lamp type, the HPL lamp. Fixtures that require the purchasing of multiple lamp types to achieve different field angles shall not be acceptable.

B. Lenses

1. It shall be possible to change field type of the spotlight through interchangeable lenses. No tools shall be necessary for lens changing. 360° Beam rotation shall be possible while the unit is active. No tools shall be necessary for lens rotation. Fixtures which require user to touch the lamp or lamp socket to orientate the beam shall not be acceptable.
   a. Interchangeable lens sets shall consist of very narrow spot, narrow spot, medium flood, and wide flood. Lenses shall be heat resistant, borosilicate glass.
   b. Beam orientation of MFL and WFL lenses shall be possible through rotation of lenses in a rotatable collar housed in the front of the unit. Collar shall be a high temperature heat resistant rotating collar with finger holds for precise movement.

C. Optical

1. The optical train shall combine a compact filament lamp with modified parabolic and multifaceted reflector. Reflector efficiency shall be a minimum of 93%. Reflector shall be cast into a heat sink assembly. Reflector finish shall be an enhanced aluminum deposition. Reflectors of pressed aluminum sheet construction shall not be acceptable.

D. Physical

1. The spotlights are constructed of rugged, die cast aluminum, free of burrs and pits, finished in black, high temperature epoxy paint. Tools shall not be required for cleaning the reflector or lens
2. The spotlight shall provide, but not be limited to:
   a. Integral cable clamp for power leads
   b. High impact, thermally insulated knobs
c. Sealed reflector housing shall prevent all light leaks. Temperature control of reflector is obtained through 17 heat sink fins cast into the housing.

d. Interior of unit shall contain ten baffles to eliminate beam scattering and spill light.

e. Lamp socket shall be held into place by a brass self-retaining screw.

f. Lens shall be secured with cast bosses and high temperature bronze spring release. No tools shall be required to change lenses.

g. Sturdy gel frame holders with two accessory slots and a top mounted, quick release gel frame retainer

h. Rugged steel yoke with two mounting positions 300°+ Rotation of fixture within yoke

i. Positive locking, hand operated yoke clutch

3. Each unit shall be provided standard with colorframe and 36” bare lead.

4. Unit shall be nominally 11” long by 10” wide

5. Weight without “C” clamp shall be 8 lbs.

6. The spotlight shall be UL and cUL listed and so labeled

2.19 CYC LIGHT

A. The luminaire shall be a UL/C-UL Listed 2000 watt max cyc light with two recessed single contact sockets to accept double ended 4-11/16” and 6-9/16” MOL tubular (T) lamps housed in a 24 gauge patterned aluminum reflector.

B. The fixture shall be a one light unit capable of being configured, in the field, into a multiple unit striplight.

C. The body shall be constructed of all welded code gauge steel. Two sets of color frame holders shall be made of four clips each on the top and bottom of the unit. All ventilating holes shall be baffled to minimize light leaks.

D. Relamping shall be accomplished from the front of the unit without disturbing the prefocused lamp alignment. Conversion of the socket settings from one lamp length (MOL) to another shall be accomplished without disassembling the unit, and with standard hand tools.

E. The fixture shall be supplied with a color frame, a three foot three-wire lead in fiberglass sleeving, and a safety screen.

F. All painted surfaces shall be baked enamel.

2.20 WORK LIGHT

A. General

1. The luminaire shall be a UL/C-UL Listed 1000 watt max floodlight/worklight with a medium two pin socket to accept tungsten halogen lamps. The reflector shall be a patterned specular reflector designed to give a radially symmetrical pattern of light.

2. The unit shall be supplied with a clear borosilicate safety lens mounted in a steel frame. The lens frame shall be mounted in a door provided with a hinge and spring latch. The
door shall be opened from the front without the use of tools to allow for easy relamping and without disturbing the prefocused lamp setting.

3. The housing shall be constructed of 18-gauge steel. Pop rivets shall not be used in the construction of the housing. A detachable color frame holder and color frame shall be available as optional equipment. All ventilating ports shall be designed to eliminate all light leakage.

4. The instrument shall be supplied with a rigid strap yoke, and a three-foot three-wire lead encased in a black fiberglass sleeve.

5. All painted surfaces shall be baked enamel.

2.21 FOLLOWSPOT

A. Physical

1. The unit frame and enclosure shall be constructed of formed cold rolled steel and sturdy aluminum extrusions, free of burrs and protected by a black powder coat finish.

2. Handles shall be provided to facilitate smooth operation and to lift the unit.

3. The unit shall be mounted on a stable, folding three-point floor stand, with:
   a. Easy height adjustments,
   b. Horizontal Swing Control Lever and
   c. Vertical Tilt Control Lever

4. The Power Supply shall be integral to the followspot.

5. Weight of Head, including power supply, shall not exceed 34 pounds.

6. Length of head unit with color changing boomerang shall not exceed 41”.

7. A sliding panel shall provide access to lenses without the use of tools.

B. Controls

1. The Lamphouse shall as a minimum incorporate the following:
   a. Silent Fan Free air cooling system;
   b. Drop-down single ended lamp holder to permit bulb replacement without the use of hand tools;
   c. Bulb positioning controls.

2. The body of the unit shall, as minimum incorporate the following:
   a. Optical dimmer iris mechanism for smooth manual dimming;
   b. Four shutters mounted on two planes, for both vertical and horizontal masking
   c. Drop-in Nichrome steel iris
   d. Drop-in Gobo Holder
   e. Zoom focus controls with calibrations silk screened on followspot body.

   1) With the iris fully open this followspot shall be capable of producing a continuous range of field angles from 10.6 degrees in spot to 19.2 degrees in flood.
   2) At any field angle the beam shall be adjustable between soft and sharp edges.
3. The front of the unit shall house a five color, self-canceling boomerang with color filters

C. Optical

1. The unit’s optical train shall consist of
   a. Socket mounted 250 watt single-ended ceramic lamp, with the following features:
      1) 3,200°K color temperature;
      2) CRI greater than 90;
      3) Hot restrike;
      4) 4,000 hour average life.
   b. Fixed Optical Quality glass reflector and double condenser lens;
   c. Variable focus lens system utilizing Optical-quality glass;
   d. Iris/Gobo Holder, Shutters for beam shaping control;
   e. Optical dimmer Iris
   f. Five color boomerang.

2.22 FIXTURE ACCESSORIES

A. Provide the following:
   1. (3) 50' Proplex Ethernet Cable
   2. (10) 5' 12/3 stage-pin extension cables
   3. (10) 10' 12/3 stage-pin extension cables
   4. (5) 25' 12/3 stage-pin extension cables
   5. (12) 18" stage-pin two-fers
   6. (24) Sheets Color Media (choice by owner)
   7. (2) Lex Products 50' E-String
   8. (8) 400PH-A Pattern Holders
   9. 10% spare lamps, minimum (1) of each type

PART 3 - EXECUTION

3.1 INSTALLATION

A. It shall be the responsibility of the Electrical Contractor to receive and store the necessary materials and equipment for installation of the dimmer system. It is the intent of these specifications and plans to include everything required for proper and complete installation and operation of the dimming system, even though every item may not be specifically mentioned. The contractor shall deliver on a timely basis to other trades any equipment that must be installed during construction.

B. The electrical contractor shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.
C. The electrical contractor shall install all lighting control and dimming equipment in accordance with manufacturer’s approved shop drawings.

D. All branch load circuits shall be live tested before connecting the loads to the dimmer system load terminals.

3.2 MANUFACTURER’S SERVICES

A. Upon completion of the installation, including testing of load circuits, the contractor shall notify the dimming system manufacturer that the system is available for formal checkout.

B. Notification shall be provided in writing, two weeks prior to the time factory-trained personnel are needed on the job site.

C. No power is to be applied to the dimming system unless specifically authorized by written instructions from the manufacturer.

D. The purchaser shall be liable for any return visits by the factory engineer as a result of incomplete or incorrect wiring.

E. Upon completion of the formal check-out, the factory engineer shall demonstrate operation and maintenance of the system to the owner’s representatives. Training shall not exceed four working hours. Additional training shall be available upon request.

3.3 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two years from date of delivery.

B. Warranty shall cover repair or replacement of such parts determined defective upon inspection.

C. Warranty does not cover any product or part of a product subject to accident, negligence, alteration, abuse or misuse. Warranty does not cover any accessories or parts not supplied by the manufacturer.

D. Warranty shall not cover any labor expended or materials used to repair any equipment without manufacturer’s prior written authorization.

END OF SECTION 26 5561
SECTION 26 5600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Exterior luminaires with lamps and ballasts.
2. Poles and accessories.

B. Related Sections:

1. Division 26: Interior Lighting
2. Division 31: Earthwork
3. Division 32: Exterior Improvements
4. Division 33: Utilities

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. Pole: Luminaire support structure, including tower used for large area illumination.

G. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
B. Live Load: Single load of 500 lbf distributed as stated in AASHTO LTS-4-M.

C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1.5 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
   a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Ballasts, including energy-efficiency data.
7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
8. Materials, dimensions, and finishes of poles.
9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
10. Anchor bolts for poles.
11. Manufactured pole foundations.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and ballasts.

D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
E. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

F. Field quality-control reports.

G. Operation and Maintenance Data: For luminaires, poles, luminaire lowering devices to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

1.6 ILLUMINATION DATA

A. For all exterior applications, provide isofootcandle (isolux) computer generated plot diagram of maintained footcandles at grade, unless noted otherwise, that shows composite values of illuminance projected from the arrangement of light fixtures as shown and as scheduled, including mounting heights. Indicate on the graphic plots the locations, spacing, light loss factor applied, and heights of fixtures. All lighting design criteria below shall be met or fixtures shall not be accepted:

<table>
<thead>
<tr>
<th></th>
<th>Parking</th>
<th>Roadways</th>
<th>Walkways</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Footcandles (Min)</td>
<td>0.50</td>
<td>0.25</td>
<td>0.25</td>
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<tr>
<td>2. Footcandles (Minimum Avg)</td>
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<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>3. Brightness ratio (Avg/Min)</td>
<td>4:1</td>
<td>4:1</td>
<td>3:1</td>
</tr>
<tr>
<td>4. Maximum pole height as indicated on &quot;LIGHTING FIXTURE SCHEDULE&quot;.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Maximum pole spacing as indicated on Drawings.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.


E. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five (5) years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five (5) years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five (5) years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than Three (3) years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten percent (10%) of the total quantity of lamps for each lamp type/wattage, rounded down to the nearest whole number. Furnish at least one (1) of each lamp/wattage type.
2. Ballasts: One percent (1%) of each type and rating installed, rounded down to the nearest whole number. Furnish at least one (1) of each type and rating.
3. Plastic Diffusers and Lenses: One percent (1%) of each type installed, rounded down to the nearest whole number. Furnish at least one (1) of each type.
4. Globes and Guards: Five percent (5%) of each type installed, rounded down to the nearest whole number. Furnish at least one (1) of each type.
B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 90 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

1. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

1. Retain "Factory-Applied Finish for Steel Luminaires" Paragraph below when luminaire material is steel that is not to be field painted and is not required to match finish of pole or support materials.

   a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove
mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

b. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.


a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

d. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

4. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

a. Label shall include the following lamp and ballast characteristics:

1) "USES ONLY" and include specific lamp type.
2) Lamp diameter code (T-4, T-5, T-8), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
3) Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
4) Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
5) ANSI ballast type (M98, M57, etc.) for HID luminaires.
6) CCT and CRI for all luminaires.

2.3 FLUORESCENT BALLASTS AND LAMPS

1. Temperatures 0 Deg F and Higher: Electronic or electromagnetic type rated for 0 deg F starting and operating temperature with indicated lamp types.
2. Temperatures Minus 20 Deg F and Higher: Electromagnetic type designed for use with indicated lamp types.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Total Harmonic Distortion Rating: Less than 10 or 20 percent.


5. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F or minus 20 deg F and higher.

2.4 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.

2. Minimum Starting Temperature: Minus 22 deg F.

3. Normal Ambient Operating Temperature: 104 deg F.

4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.

2.5 HID LAMPS

A. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000K.

B. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and CCT color temperature 4000K.

2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Shall not cause galvanic action at contact points.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all, except wood poles.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

2.7 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.

   1. Shape: Square straight.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as luminaire.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
   3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

2.8 DECORATIVE POLES

A. Pole Material:
   1. Cast ductile iron.
   2. Cast gray iron, according to ASTM A 48/A 48M, Class 30.
   3. Cast aluminum.
   5. Spun concrete.
   6. Steel tube, covered with closed-cell polyurethane foam, with a polyethylene exterior.

B. Mounting Provisions:
   1. Bolted to concrete foundation.
   2. Embedded.

C. Fixture Brackets:
   1. Cast ductile iron.
   2. Cast gray iron.
   3. Cast aluminum.

2.9 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.
3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers unless otherwise indicated.
   4. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRE

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."
3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

   b. IESNA LM-64, "Photometric Measurements of Parking Areas."
   c. IESNA LM-72, "Directional Positioning of Photometric Data."

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 27.

B. This section is a Division 27 COMMUNICATIONS section, and is a part of each Division 27 Section.

C. Requirements of the following Division 27 Sections apply to this section:

1. Division 27 Section 27 0500 “Common Work Results for Communications”.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01 - reference individual sections for further expansion of these requirements:

1. Abbreviations and Definitions
2. Permits, Codes, and Inspections
3. Visiting Premises
4. Submittals
5. Project Drawings and Specifications
6. Cooperation and Coordination with Other Trades
7. Product Listing
8. Nameplate Data
9. Record Documents
10. Maintenance Manuals
11. Warranty
12. Delivery, Storage, and Handling
13. Sequence of Work
14. Electrical Installations
15. Cleaning
16. Testing
17. Instructions to the Owner

1.3 CONTRACTOR QUALIFICATIONS

A. The apparent low bidder shall demonstrate their qualifications by providing the following documents for the local area network cabling:
1. A listing of the LAST five (5) Local Area Network (LAN) systems that were installed by the bidder:
   
a. The listing shall include only LANs that included the installation of fiber optic cable, unshielded twisted pair (UTP) cable, and Gigabit Ethernet equipment.
   b. The listing shall be for the last five projects, regardless of size or location, which are operational and have been turned over to the Owner.
   c. The listing shall include a brief description of the project, type of LAN, size of the system, Owner's name and address and representative, date started, and date of completion.
   d. The listing shall include a letter from the Owner of each of the 5 projects. The letter shall be on the Owner's letterhead and shall be signed by an officer or authorized agent of the Owner. The letter shall state the overall satisfaction or dissatisfaction with the performance of the Contractor, and the quality of workmanship in regards to installation of the cabling, hardware, and software.

2. The bidder shall furnish a list of the names of all full-time employees that the Contractor plans to use on the project.
   
a. The listing shall include each person’s title, length of current employment with the company, training, and certification.
   b. The listing shall also include a resume for the Project Manager.
   c. The listing shall also include registration number and a copy of the current BICSI certificate for each RCDD.

B. All bidders shall be certified and registered by the applicable cable/connector manufacturer and submit certifications of training in the installation and maintenance of the specified systems.

C. The bidder shall furnish a list of all test equipment that will be used in the installation and testing of the fiber optics cable and the twisted pair cable.

D. All of the above documents shall be submitted within 48 hours (excluding weekends and holidays) following the Bid due date/time.

1.4 ABBREVIATIONS

A. General: Utilize the following abbreviations and definitions for discernment within the Drawings and Specifications.

1. Abbreviations:
   
a. ANSI American National Standards Institute
   b. ASA American Standards Association
   c. ASTM American Society of Testing Materials
   d. BICSI Building Industry Consulting Services International
   e. CBM Certified Ballast Manufacturers
   f. EC Electrical Contractor
   g. EIA Electronic Industries Association
   h. ETL Electrical Testing Laboratories, Inc.
   i. GC General Contractor
1.5 DEFINITIONS

A. PROVIDE means to furnish, place, erect, connect, test, and turn over to Owner, complete and ready for the regular operation, the particular work referred to.

B. INSTALL means to join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation, the particular work referred to.

C. FURNISH means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories, and all other items customarily required for the proper and complete application for the particular work referred to.

D. WIRING means the inclusion of all raceways, fittings, conductors, connectors, tape, junction and outlet boxes, connections, splices, and all other items necessary and/or required in connection with such work.

E. CONDUIT means the inclusion of all fittings, hangers, supports, sleeves, etc.

F. AS DIRECTED means as directed by the Architect or their representative.

G. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within double partitions or installed within hung ceilings.

H. ACCEPTED means as accepted by the Architect or their representative.

I. APPROVED means as approved by the Architect or their representative.

J. EQUAL means equivalent as approved by the Architect or their representative.

K. CONTRACTOR as stated herein shall mean Communication Contractor.
1.6 PERMITS, CODES, AND INSPECTIONS

A. General: Contractor shall obtain and pay for all permits and inspections required by laws, ordinances, rules, and regulations having jurisdiction for work included under this Contract, and shall submit approval certificates to the Architect.

B. Codes: The installation shall comply fully with all local, county, and state laws, ordinances and regulations applicable to local area network and related communication installations.

C. The installation shall be in compliance with the requirements of the latest revisions of:

1. Building Communication International (BISCI)
2. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA)
3. Occupational Safety and Health Act (OSHA)
4. Institution of Electrical and Electronic Engineers (IEEE)
5. National Electric Code (NEC)
6. Underwriter's Laboratories, Inc. (UL)
7. National Electrical Manufacturer's Association (NEMA)
8. National Electrical Contractor's Association (NECA)
10. Legislative Act 235 (1965) - Handicapped
11. Legislative Act 287 (1974) - Excavation
13. Americans with Disabilities Act (ADA)
14. All approved published instructions set forth by equipment manufacturers.

D. The installation shall be in compliance with the requirements of:

1. Middle Department Inspection Agency (MDIA)
   a. Exception: Where the regulations of the local municipality require inspection services by an agency other than MDIA.
2. All local codes and ordinances in effect and having jurisdiction.
3. All requirements of electrical power utility companies.
4. All requirements of telephone utility companies.
5. All requirements of cable television utility companies.

E. Submit certificates issued by approved authorized agencies to indicate conformance of all work with the above requirements, as well as any additional certificates as may be required for the performance of this contract work.

F. Should any change in Drawings or Specifications be required to comply with governmental regulations, the Contractor shall notify Architect prior to execution of the work. The work shall be carried out according to the requirements of such code in accordance with the instructions of the Architect and at no additional cost to the Owner.

G. Certificate of Inspection: The Contractor shall procure and pay for the Certificate of Inspection from MDIA, or other required inspection agency, and deliver it to the Architect before final payment is made.
1.7 VISITING PREMISES

A. General: The Bidder shall visit the project site before submitting his/her bid, in order to familiarize him/herself with existing conditions that may affect the work. It is the Contractor's responsibility to analyze existing conditions. Sufficient allowances shall be provided in the Contractor's bid to cover work, due to existing conditions, that will be required to complete this contract work.

B. By submission of a bid the Contractor is attesting that responsible personnel did, in fact, visit the site during the bidding period, and verified all existing pertinent conditions.

C. Contractor shall verify all measurements and dimensions at the site prior to submitting a bid.

1.8 SUBMITTALS

A. General: Follow the procedures specified in Division 1 and as stated below.

B. The Contractor shall submit a complete set of Project Documents and complete product data for the proposed system to the system vender for review prior to submission to the Architect/Engineer. The System Vender shall review the complete system package and provide documentation attesting to the system compliance with the extended system product and performance warranty. This documentation must accompany all submittals to the Architect/Engineer. Submittals will not be reviewed by the Architect/Engineer without the System Vender approval documentation.

C. Submit for approval a complete Material Source of Supply and Subcontractor list for all work required under this project. Shop drawing submittals will not be reviewed until a complete Material Source of Supply and Subcontractor list is received.

D. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect, will not be processed.

E. Prepare and submit detailed shop drawings for materials, systems, and equipment as listed herein, including locations and sizes of all required openings in floor decks, walls and floors.

F. The work described in any shop drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job. Each submitted shop drawing shall include a certification that all related job conditions have been checked and that no conflict exists.

G. All shop drawings shall be stamped by the Contractor, indicating approval, and space shall be provided for the Engineer's stamp and the Architect's stamp.

H. All drawings shall be submitted sufficiently in advance of field requirements to allow ample time for checking and re-submittal as may be required. All submittals shall be complete and contain all required and detailed information.
I. Acceptance of any submitted data or shop drawings for material, equipment apparatus, devices, arrangement and layout shall not relieve the Contractor from responsibility of furnishing all items of proper dimensions, weight, capacities, sizes, quantity and quality as intended by the Contract. Such acceptance shall not relieve the Contractor from responsibility for errors, omissions, or inadequacies of any sort on submitted data or shop drawings.

J. Each shop drawing shall contain job title and reference to the applicable drawing and specification article, including the Contractor’s drawings, specifications, and verification of compatibility with the systems involved.

K. Individual shop drawing submittals shall be provided for each specific material, system or equipment as identified herein. Submittals provided in other than this manner will be return without review.

L. All nameplate data shall be complete at time of equipment submittals - refer to other sections for identification requirements.

M. For each room or area of the building containing sound system cabinets, telephone backboards, consoles, etc., coordination drawings are required to be submitted for review and acceptance at the time of the equipment submittal.

N. Equipment shall not be purchased until the shop drawing approval is received.

O. Shop Drawings shall show conformance with specified equipment characteristics, or Contractor shall assume responsibility for all deviations including all additional costs involved for the deviations.

P. The following is a list of some important material, equipment and systems that require shop drawing approval, refer to each section of this specification for additional submittal requirements:

<table>
<thead>
<tr>
<th>Outlet Boxes</th>
<th>Sound System(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Networking Systems</td>
<td>TV Distribution System</td>
</tr>
<tr>
<td>Wiring/Cables</td>
<td>Data Network</td>
</tr>
<tr>
<td>Projectors and Video Equipment</td>
<td></td>
</tr>
</tbody>
</table>

Q. Submittals shall include plan, riser and wiring diagrams complete with all wiring and required equipment.

R. Product Options:

1. The product manufacturers listed in each section are either the product the design is based on or a product that the Engineer feels would be an acceptable substitution if that product can meet the intent of the written specifications and the scheduled capacities. The Communication Contractor is responsible for ensuring that the substituted product complies with the intent of the specifications, the scheduled capacities and the drawings. Substitutions of manufacturers not listed are not permitted unless prior approval is obtained from the Engineer as required by Part 2.2, SUBSTITUTIONS, of this specification section.
2. It will be the responsibility of the Communication Contractor to pay any and all costs associated with any approved substitutions that impact the architectural layout, structure, electrical system(s), mechanical systems, and/or the plumbing systems, due to an increase in physical dimensions, weight, electrical requirements, connection sizes, etc., between the approved substitution item and the equipment item scheduled and/or indicated as the basis of design.

S. In order for the manufacturer to certify this local area network cabling system, the system components must meet the requirements of the manufacturer. Review the system with the manufacturer in accordance with their system certification program and provide a letter from the manufacturer documenting the following:

1. That the Contractor is a manufacturer certified installer.
2. That all the materials in the submittal are in accordance with the manufacturer's certification program.
3. That the manufacturer has reviewed the entire system in accordance with their certification program and the system is in compliance.

T. A system that does not have a manufacturer's certification will not be accepted.

1.9 PROJECT DRAWINGS AND SPECIFICATIONS

A. Contractor shall carefully examine the Drawings and Specifications of all trades and report all discrepancies to the Architect in writing to obtain corrective action. No departures from the Contract Documents will be made without prior written approval from the Architect.

B. Questions or disputes regarding the intent or meaning of Contract Documents shall be resolved by the interpretation of the Architect. The Architect's interpretation is final and binding.

C. The Drawings and Specifications are not intended to define all details, finish materials, and special construction that may be required or necessary. The Contractor shall provide all installations complete and adequate as implied by the project documents.

D. Drawings are diagrammatic only and do not show exact routes of cabling and locations of equipment. The Contractor shall verify the work of all other trades and shall arrange his work to avoid conflicts. In the event of a conflict, the Contractor shall obtain corrective action from the Architect.

E. All work shall be considered new, unless noted otherwise.

1.10 COOPERATION AND COORDINATION WITH OTHER TRADES

A. This Contractor shall cooperate completely and coordinate work with the contractors of other trades. Due to the Project Schedule this Contractor will be required to phase the installation in accordance with the Electrical Contractor's work.

B. Prepare floor plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination
of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Specific equipment installations, including, but not limited to racks for LAN equipment, racks for sound system equipment, cable television equipment, etc.
2. Where additional conduit sleeves are required in order to limit UTP cable length to 90 meters.
3. Wiring diagrams: Indicating field installed communication wiring and cabling layouts, equipment, and equipment connections.

1.11 PRODUCT LISTING

A. Prepare a listing of equipment and materials for the project.

B. Submit this listing as a part of the submittal requirement specified in Division 1.

C. When two or more items of same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, fasteners, and similar items used in work, except as otherwise indicated.

D. Provide products that are compatible within systems and other connected items.

1.12 NAMEPLATE DATA

A. Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplate in an accessible location.

1.13 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1.

B. When all work has been completed and before final acceptance, the Contractor shall furnish to the Architect a complete set of reproducible contract drawings clearly showing all contract work "as-built". Prior to delivery each drawing shall be signed and dated by the Contractor's project manager attesting to the accuracy of the as-built drawing.

C. In addition to the above referenced reproducible contract drawings, the Communication Contractor shall furnish to the Architect a CD-Rom containing all of the floor plans. The floor plans shall be in AutoCAD 2007 format, and shall indicate the “as-built” conditions. A CD-Rom shall be provided to the Communication Contractor prior the completion of the project, with the drawing files from the bid set of documents. The Communication Contractor shall make changes to these files, indicating all changes made during construction, including tagging and room names. The Communication Contractor shall make these changes or retain the services of a third party to make the changes.

D. Mark up a clean set of Specifications to indicate approved substitutions, change orders and actual equipment and materials used.
1.14 OPERATION MANUALS

A. Prepare operation manuals in accordance with Division 1. In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's data of each piece of equipment including:
   a. Installation instructions.
   b. Drawings and Specifications.
   c. Parts list, including recommended items to be stocked.
   d. Complete wiring diagrams.
   e. Marked or changed prints locating all concealed parts and all variations from the original system design.
   f. Test and inspection certificates.

B. Format:

1. Provide five (5) copies of each manual.
2. Manuals to be 8-1/2 inches x 11 inches size in hard back 3-ring loose-leaf binders. Use more than one volume if required. Do not overfill binders.
3. Submit one (1) copy to Architect. After review and acceptance, assemble other copies.
4. Manuals to be completed and in Owner's hands prior to turning building over to Owner and at least 10 days prior to instruction to operating personnel.

1.15 WARRANTIES

A. Refer to the Division 1 for procedures and submittal requirements for warranties and to individual equipment specifications for additional warranty requirements. If a contradiction exists, the most demanding requirements shall prevail.

B. Compile and assemble the warranties specified in Division 27 into a separated set of vinyl covered, three-ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include date of beginning of warranty or bond; duration of warranty or bond; and names, address, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. Warranty and Certification of the Data Network Wiring and connectors:

1. The Contractor shall provide a minimum 25-year performance and product warranty that all cable, connectors, and connecting hardware shall be free from defects in material, workmanship, and fabrication.
2. The system shall be certified by the cable/connector manufacturer and warranted for the specified performance for a minimum of 25 years. The Contractor shall conform to the manufacturer's certification program including testing and the submittal of all required documentation to the manufacturer.
3. The Contractor shall obtain from the manufacturer, a “systems application assurance” warranty for a minimum of 25 years.
4. The Contractor shall obtain, from the manufacturer, a Registration Document and Certificate for the specific installation. Upon receipt of the Registration Document and Certificate the Contractor shall forward a copy to the Engineer and deliver the original to the Owner.

5. The certification shall be equivalent to the Hubbell Premise Wiring “Clear Bit Mission Critical” 25-year warranty Program.

E. Submit a single warranty stating that all portions of the work are in accordance with Contract requirements. Warrant all work against faulty and improper material and workmanship for a period of one (1) year from date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are specified herein, such longer term shall apply. Within 24 hours after notification, correct any deficiencies that occur during the warranty period at no additional cost to Owner, all to the satisfaction of the Owner. Obtain similar warranties from subcontractors, manufacturers, suppliers, and sub-trade specialists.

F. Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract Documents or which are damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the Owner.

PART 2 - PRODUCTS

A. Major items of equipment shall have manufacturer's name, address and catalog number on a plate securely attached in a convenient place. All equipment or apparatus of any one system must be the product of one manufacturer, or approved equivalent products of a number of manufacturer's that are suitable for use in a unified system.

B. All materials and equipment for which Underwriter's Laboratories have established standards shall bear a UL label of approval.

C. In all cases where a device, function or item of equipment is herein referred to in the singular, such reference shall apply to as many such items as are required to complete the installation.

D. All listed materials and equipment shown on drawings and/or specified herein, are indicative of complete and whole units and shall be furnished as such.

E. In certain instances specific manufacturer/model/type and catalog numbers are set out herein or on the drawings for the purpose of indicating required criteria for quality, function, and acceptable physical size. Specifications, performance data, and descriptive data published by the designated manufacturer shall be taken as minimum requirements for the item to be provided.

F. Comply with manufacturer's printed instructions and recommendations as minimum criteria for the installation of equipment.

G. Where proprietary names are used, whether or not followed by the words "or as approved", they shall be subject to substitution only as approved by the Architect.
H. Where the contractor proposes substitute equipment he shall submit acceptable evidence to indicate compliance with all requirements of the documents, including performance rating, equivalent to the specified item. In instances where substituted equipment requires additional material or work beyond that shown or required by the specified item, said additional material or work shall be the responsibility of this Contractor, regardless of the trade involved.

I. All materials and equipment provided under this Contract shall be completely satisfactory and acceptable in operation, performance and capacity. No approval, either verbal or written, of any drawing, descriptive data or samples of such materials, equipment and/or appurtenances, shall relieve this Contractor of his responsibility to turn over all items in perfect working order at completion of the work.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for distinct identification; adequately packaged and protected to prevent damage during shipment, storage and handling.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. Coordinate deliveries of materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

3.2 SEQUENCE OF WORK

A. Construct work in a sequence in accordance with Division 01.

B. Due to current Project Schedule the Contractor will be required to phase the installation in accordance with the Electrical Contractor's work.

3.3 INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for installations of cabling. Arrange such chases, slots and openings such that UTP cable does not exceed 90 meters.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
9. Coordinate the cutting and patching of building components to accommodate installation of equipment and materials.
10. Coordinate the installation of materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
11. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.

3.4 CLEANING
A. Refer to the Division 1 Section for general requirements for final cleaning.

3.5 TESTING
A. Contractor, at his own expense, shall make any and all tests directed by an inspection authority, or connector manufacturer, or the Architect, and shall provide all equipment, instruments and materials to make such tests.
B. Unless otherwise approved, all terminations shall be made and all components shall be in place, complete and operational, at time of final inspection and tests.
C. Time of such tests, the manner in which they are made and the results of the tests, shall be subject to approval.
D. Upon completion of work, all component parts, both singularly and as a whole, shall be set, calibrated, adjusted, and left in satisfactory operating condition to suit load conditions, by means of instruments furnished by the Contractor.
E. Complete testing of equipment and systems shall be provided throughout this project.
F. Industry standards shall apply except as otherwise specified.
G. Provide all labor, premium labor, and materials required by field-testing as specified in the Contract Documents and as required.
H. Notify the Architect seven (7) days prior to the testing dates. Upon completion of a test, a statement of certification shall be forwarded to the Architect for his approval.
I. Conduct tests at a time agreeable to the Architect. Provide premium labor as necessary.

J. Products that are found defective or do not pass such tests shall be removed and replaced at the Contractor's expense. Tests shall be repeated.

3.6 INSTRUCTIONS TO THE OWNER

A. After the tests and adjustments have been made, approved factory-authorized system representatives and the Contractor shall fully instruct Owner in all details of operation and maintenance of equipment installed under this Contract. Dates and times of such instructions shall be as directed by Owner, including any necessary weekend or after-hours instruction.

B. Additional instruction requirements are included in each section of the Specifications.

C. The Contractor shall video tape all instruction sessions. Prepare a separate video tape for each system as shown on the schedule below. Clearly label the tape with the title “INSTRUCTIONS FOR THE USE OF …”, on both the face and the spine, in typewritten letters. Two (2) copies of each video tape shall be given to the Owner at the completion of the Contract; one (1) set for the maintenance staff and one (1) set for the administrative staff.

D. Prepare an instructional training form indicating the topic of instruction, the date, the time, the purpose of instruction and lines for signatures of attendees. Each person attending the instruction shall print their name and sign the form. Provide a copy of the completed form to the Owner in the O&M manual as proof of instructional training. The Contractor shall keep the original in the Contractor’s project file.

E. The attached schedule indicates the extent of training.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Spec. Sec.</th>
<th>Session 1</th>
<th>Session 2</th>
<th>Session 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>F(1) L(2)</td>
<td>A(3)</td>
<td>F(1) L(2)</td>
</tr>
<tr>
<td>Sound System 1</td>
<td>27 5120</td>
<td>I</td>
<td>I</td>
<td>M</td>
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<tr>
<td>Sound System 2</td>
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<td>Sound System 6</td>
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</tr>
<tr>
<td>Television Distribution</td>
<td>27 4133</td>
<td>I</td>
<td>I</td>
<td>M</td>
</tr>
<tr>
<td>Cabling/Rack/Cabinets</td>
<td>27 1100</td>
<td>I</td>
<td>A/R</td>
<td>M</td>
</tr>
</tbody>
</table>

Other Systems not listed above – refer to individual Specification Section

Format: Provide training in the following format:

I = Initial meeting to discuss system operation, safety issues, maintenance issues.
1F = Follow-up session, 1 month from initial session.
2F = Follow-up session, 2 months from initial session.

Length: Provide the length of instruction as follows:

1, 2, 3, etc. indicates the number of hours of training; does not include travel time, setup time, question/answer time.
A/R = as required by Owner or the number of attendees.
Attendees:
A = Administrative Staff, as determined by Owner’s representative.
M = Maintenance Staff, as determined by Owner’s representative.
T = Teaching Staff, schedule multiple sessions to limit instructional session size to 15 people.

Specification Section:
Refer to the individual specification sections for additional training requirements.

END OF SECTION 27 0100
SECTION 27 0500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   
   B. Requirements of the following Division 17 Sections apply to this section:
      
      1. Division 27 Section 27 0100 “Basic Communication System Requirements”.

1.2 SUMMARY
   
   A. This Section includes limited scope general construction materials and methods for application with electrical installations as follows:
      
      1. Firestopping.
      2. Locations
      3. Scaffolding
      4. Painting

PART 2 - PRODUCTS

2.1 FIRESTOPPING
   
   A. Acceptable Manufacturers: Subject to compliance with UL requirements, one of the following:
      
      1. 3M
      2. Tremco
      3. International Protective Coatings
      4. Nelson
      5. Rectorseal/Metacaulk
   
   B. Use only that manufacturer listed in UL Fire Resistance Directory for the UL system involved.

   C. All firestopping materials used on this project shall be the products of one manufacturer. Each trade shall use products of the same manufacturer.

   D. Standards: The firestop systems and products shall have been tested in accordance with the procedures of U.L. 1479 (ASTM E814-81) and material shall be UL classified as Fill, Void or Cavity Materials for use in Through-Penetration Firestops. The firestop system shall comply with NEC Paragraph 300-21. All work shall comply with NFPA 101-Life Safety Code, Latest Edition.
2.2 FIRE-RATED WALL PENETRATIONS

A. Description: Manufactured fire rated pathways and sleeves, designed for field assembly, to restore original fire resistance rating of floor and wall while allowing the ability to freely install or remove cabling without affecting the fire rating of device.

1. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Specified Technologies Inc., E-Z Path
   b. Wiremold, FlameStopper
   c. Engineer approved equal.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, a nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 GENERAL

A. All construction under this contract shall be completed in a neat and craftsman like manner. Work that, in the judgment of the Architect, is not satisfactorily installed shall be removed and replaced to the Architect's satisfaction, at the Contractor's expense.

B. Housekeeping: Throughout construction, all work areas and storage areas shall be kept clean. The Contractor shall keep all items clean of dirt, rust, dust and finger marks.

3.2 FIRESTOPPING

A. Where communication conduits, conduit sleeves, wire ways, and other raceways or cables pass through fire partitions, fire walls, fire floors, or smoke walls, the Contractor shall provide a fire or smoke stopping that provides an effective barrier against the spread of fire, smoke or gases.

B. Installation of Fire-Stopping Materials: Install materials to fill openings around services penetrating floors and walls and provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Install materials in accordance with printed instructions of the UL Fire Resistance Directory and per manufacturer's published instructions.

C. All cables that are installed in conduit sleeves or in wire ways through fire or smoke floors or partitions shall be provided with an equally rated re-enterable U.L. listed fire and smoke rated silicone RTV foam in the opening.

D. Examine fire/smoke-stopped areas to ensure proper installation before concealing or enclosing areas.
E. Keep areas of work accessible until inspection by applicable code authorities.

3.3 LOCATIONS

A. Obtain written approval of locations of all devices from the Owner and Architect prior to rough-in/installation. The owner reserves the right to move any or all communication devices prior to installation, at no additional cost.

B. Contractor shall obtain detailed and specific information regarding location of all equipment. Final locations may differ from those indicated on Drawings. Work improperly placed because of Contractor's failure to obtain this information shall be relocated and reinstalled as directed, without additional costs to the Contract.

C. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of equipment without prior written approval.

3.4 SCAFFOLDING

A. The Contractor shall furnish, set, erect, and maintain all scaffolding, aerial equipment and ladders required in the installation of this Contract work.

B. Install temporary platforms so as to be supported only by the existing steel truss framework. Do not allow any additional loading from construction operations to transfer to suspended lath and plaster ceilings.

3.5 PAINTING

A. Except in Mechanical Rooms, Electrical Rooms, all exposed items provided or installed under this Contract shall be painted in accordance with Division 1 requirements.

B. Unless painting is provided by others, as elsewhere specified, all painting for items furnished or installed under this Contract shall be the responsibility of this Contractor.

C. Factory-painted equipment cabinets and trim shall not be field-painted except for touching up scratches or damage where necessary to achieve like-new finish. Touching up shall be done after equipment is in its final location.

D. Items to be painted shall be cleaned and degreased and shall be free of dirt, rust and corrosion prior to application of paint.

E. All paint shall be applied in accordance with all the manufacturer's recommendations (i.e. temperature, dew point, ventilation).

END OF SECTION 27 0500
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SECTION 27 0523 - CONTROL VOLTAGE COMMUNICATION CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to this section.

B. Requirements of the following Division 27 Sections apply to this section:
   1. Basic Communication Systems Requirements.
   2. Common Work Results for Communications.

1.2 SUMMARY

A. This Section includes cables designed and used for electrical transmission in control, data, and signal circuits including:
   1. Twisted Pair cable.
   2. Coaxial cable.
   3. Video Pair cable.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Submittals shall be made with the corresponding system submittal as complete systems including all required accessories and special installation tools (i.e., termination hardware).

C. Product Data for control/signal transmission cable and connectors, including the following cable transmission characteristics:
   1. Mutual Capacitance
   2. DC Resistance
   3. Characteristic Impedance
   4. Attenuation
   5. Near-end Crosstalk (NEXT)
   6. Nominal Velocity of Propagation

D. Manufacturers complete installation instructions including the following information:
   1. Minimum bend radius
   2. Maximum pulling tension
   3. Recommended installation of pulling points (i.e., every 180 degrees of bends in the conduit, or every 150 feet of conduit)
   4. Recommended pulling lubricants
E. Product Certificates signed by the communication system manufacturers, certifying that the cables and termination hardware is suitable for the connected equipment and is certified to meet the standards described in Quality Assurance below.

F. Provide information regarding all termination, splitting and splicing connectors that will be required to complete this installation. This information shall include complete specifications and installation instructions including tightening requirements.

1.4 QUALITY ASSURANCE

A. Connected Equipment Manufacturer Approval: Where cables specified in this Section are used to provide signal paths for systems specified in other sections of these Specifications or for systems furnished under other contracts, obtain review of the cable characteristics and approval for use with the connected system equipment by the connected equipment manufacturers.

B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."

C. Toxicity: Comply with applicable codes and regulations regarding toxicity of combustion products of materials used in control/signal transmission media.

D. UL Compliance: Comply with applicable requirements of UL Standard 910 "Test Method for Fire and Smoke Characteristics of Cables Used in Air Handling Spaces". Provide products that are UL-listed and labeled for such use.

E. NEMA/ICEA Compliance: Comply with NEMA/ICEA Standard WC 41, "Coaxial Communication Cable."

F. Comply with the following Electronic Industries Association (EIA) and Telecommunications Industry Association (TIA) Standards:

1. EIA/TIA-568, "Commercial Building Telecommunications Wiring Standard"
2. EIA/TIA-569, "Commercial Building Standard for Telecommunications: Pathways and Spaces"
3. EIA/TIA-570, "Residential and Light Commercial Telecommunications Wiring Standard"
4. TIA/EIA-606, "The Administration Standard of the Telecommunications Infrastructure of Commercial Building"
5. TSB-36, Technical Systems Bulletin, "Additional Cable Specifications for Unshielded Twisted-Pair Connecting Hardware"
7. EIA Standards EIA-230, "Color Marking of Thermoplastic Wire" and
8. EIA-258, "Semi-Flexible Air Dielectric Coaxial Cables and Connectors, 50 Ohms."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver cable factory-packaged in containers or reels. Store in clean dry space and protect products from damaging fumes and traffic. Handle wire and cable carefully to avoid damage.

PART 2 - PRODUCTS

2.1 GENERAL

A. All cable installed in cable tray shall have a plenum rating.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

1. Cable:
   a. AT&T Network Systems
   b. The Siemon Company
   c. Belden Division; Cooper Industries
   d. Mohawk Wire & Cable Corporation
   e. West Penn Wire Corporation
   f. AMP

2. Connectors:
   a. Thomas & Betts Corporation
   b. 3M Company
   c. Blounder Tongue
   d. Macom
   e. AMP

2.3 CONTROL/SIGNAL TRANSMISSION CABLE AND CONNECTORS

A. General: Provide control/signal transmission cable and connectors of manufacturer's standard materials as indicated on the drawings. All cables shall be designed and constructed as recommended by the system/equipment manufacturer, for a complete installation and for applications indicated.

2.4 APPLICATIONS

A. Install control/signal cables and connectors for the following systems:

1. Intercom networks.
2. Telephone systems.
3. Television systems.
PART 3 - EXECUTION

3.1 INSTALLATION OF CONTROL/SIGNAL CABLE AND CONNECTORS

A. Conductors and cables for communications and signal systems shall be installed with a minimum 18” clearance from light fixtures, electrically operated equipment and all wiring operating at 120 or more volts.

B. Conductors and cables for communications and signal systems shall be type, size and insulation as recommended by manufacturer and approved. Install in accordance with manufacturer's written instructions and in compliance with NEC.

C. Coordinate installation with other Work.

D. Install without damaging conductors, shield, or jacket.

E. Do not either in handling or installation bend cable to smaller radii than minimum recommended by manufacturer.

F. Ensure that minimum manufacturer's recommended pulling tensions are not exceeded.

G. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway.

H. Use pulling compound or lubricant where necessary; compound used must be approved by the cable manufacturer.

I. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

J. No splices are allowed except at indicated splice points.

K. Use splice and tap connectors that are compatible with media material.

L. Tighten connectors and terminals, including screws and bolts in accordance with manufacturer's published instructions or torque tightening values.

3.2 COLOR CODING

A. All wiring for communications and signal systems shall be color coded, using black, red, white, yellow, blue and brown with tracers as required. There shall be no two wires of same trace color in the same cable. This color coding shall be consistent and continuous throughout the system.

3.3 TRAINING

A. Provide adequate length of conductors within electrical enclosures and at punch down blocks. Train the conductors to termination points with no excess.
3.4 FIELD QUALITY CONTROL

A. Prior to usage, test wiring for electrical continuity and for short circuits. In addition, test the cable installation with a time domain reflectometer with strip chart recording capability and anomaly resolution to within one foot in runs up to 1,000 feet in length.

B. Test all cable segments for faulty connectors, splices, terminations, and the integrity of the cable and its component parts.

C. Documentation: Use the above time domain reflectometer to make a strip chart recording of transmission characteristics, wave form, and performance of all segments of the installation at the time of commissioning. Bind the recordings in a cable record book indexed for easy reference during future maintenance operations and turn book over to the Owner's authorized representative.

D. Replace malfunctioning transmission media with new materials, then retest until satisfactory performance is achieved.

3.5 COMMISSIONING

A. Subsequent to hookups of control/signal transmission media, operate control/signal systems to demonstrate proper functioning. Replace malfunctioning media with new materials, and then retest until satisfactory performance is achieved.

END OF SECTION 27 0523
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SECTION 27 0526 - GROUNDING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies general grounding and bonding requirements of electrical and telecommunication installations for personnel safety, equipment operations and to provide a low impedance path for possible ground fault currents.

B. “Grounding electrode system” refers to all electrodes required by NEC, as well as including made, supplementary, lightning protection system and telecommunications system grounding electrodes.

C. The terms “connect” and “bond” are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

A. Section 27 1100: Communications Equipment Room Fittings and Grounding

B. Section 27 0529: Hangers and Supports for Communication Systems

C. Section 27 0534: Boxes and Fittings

D. Section 27 0528: Cable Tray

1.3 SUBMITTALS

A. Submit in accordance with Section 01400 Submittal procedures

B. Shop Drawings:
   1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
   2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

C. Test Reports: Provide certified test reports of ground resistance.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
   1. Certification that the materials and installation is in accordance with the drawings and specifications.
   2. Certification, by the Contractor, that the complete installation has been properly installed and tested.
1.4 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

D. National Fire Protection Association (NFPA):
   1. 70-2005: National Electrical Code (NEC)
   2. 99-2005: Health Care Facilities

E. Telecommunications Industry Association, (TIA)

F. J-STO-607-A-2002: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

G. Underwriters Laboratories, Inc. (UL):
   1. 44-2005: Thermoset-Insulated Wires and Cables
   2. 83-2003: Thermoplastic-Insulated Wires and Cables
   3. 467-2004: Grounding and Bonding Equipment
   4. 486A-486B-2003: Wire Connectors

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

C. Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.
D. Telecom System Grounding Riser Conductor: Telecommunications Grounding Riser shall be in accordance with J STO-607A. Use a minimum 50mm² (1/0 AWG) insulated stranded copper grounding conductor unless indicated otherwise.

E. Electrical System Grounding: Conductor sizes shall not be less than what is shown on the drawings and not less than required by the NEC, whichever is greater.

2.2 SPLICES AND TERMINATION COMPONENTS

A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.3 TELECOMMUNICATION SYSTEM GROUND BUSBARS

A. Provide solid copper bus bar, pre-drilled from two-hole lug connections with a minimum thickness of 6 mm (1/4 inch) for wall and backboard mounting using standard insulators sized as follows:

1. Room Signal Grounding: 300 mm x 100 mm (12 inches x 4 inch).
2. Master Signal Ground: 600 mm x 100 mm (24 inches x 4 inch).

2.4 ROUND CONNECTIONS

A. Below Grade: Exothermic-welded type connectors.

B. Above Grade:

1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lock washers.
2. Ground Bus bars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

C. Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.

2.5 EQUIPMENT RACK AND CABINET GROUND BARS

A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x ¾ inch).

2.6 GROUND TERMINAL BLOCKS

A. At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.
2.7 SPLICE CASE GROUND ACCESSORIES
   A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

2.8 LIGHTNING ARRESTORS
   A. Lightning protectors shall be supplied on all OSP cables as specified by the manufacturer. At minimum, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

PART 3 - EXECUTION

3.1 GENERAL
   A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.
   B. System Grounding:
      1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
      2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
      3. Isolation transformers and isolated power systems shall not be system grounded.
   C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.
   D. Special Grounding: For patient care area electrical power system grounding, conform to NFPA 99, and NEC.

3.2 INACCESSIBLE GROUNDING CONNECTIONS
   A. Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

3.3 CORROSION INHIBITORS
   A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.
3.4 TELECOMMUNICATIONS SYSTEM

A. Bond telecommunications system grounding equipment to the electrical grounding electrode system.

B. Furnish and install all wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.

C. Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.

D. Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milli ohms or less.

E. Below-Grade Grounding Connections: When making exothermic welds, wire brush or file the point of contact to a bare metal surface. Use exothermic welding cartridges and molds in accordance with the manufacturer’s recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly cleaned the joint area. Notify the Resident Engineer prior to backfilling any ground connections.

F. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.

G. Bonding Jumpers:
   1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 16 mm² (6 AWG) insulated copper wire.
   2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
   3. Use compression connectors of proper size for conductors specified. Use connector manufacturer’s compression tool.

H. Bonding Jumper Fasteners:
   1. Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lock washers.
   2. Wire way and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lock washers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wire way or cable tray to prevent cable damage.
   3. Ground Plates and Bus bars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lock washers, and nuts.
   4. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lock washers.
3.5 COMMUNICATION ROOM GROUNDING

A. Telecommunications Ground Bus bars:
   1. Provide communications room telecommunications ground bus bar hardware at 950 mm (18 inches) at locations indicated on the Drawings.
   2. Connect the telecommunications room ground bus bars to other room grounding bus bars as indicated on the Grounding Riser diagram.

B. Telephone-Type Cable Rack Systems: aluminum pan installed on telephone-type cable rack serves as the primary ground conductor within the communications room. Make ground connections by installing the following bonding jumpers:
   1. Install a 16 mm² (6 AWG) bonding between the telecommunications ground bus bar and the nearest access to the aluminum pan installed on the cable rack.
   2. Use 16 mm² (6 AWG) bonding jumpers across aluminum pan junctions.

C. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:
   1. When ground bars are provided at the rear of lineup of bolted together equipment racks, bond the copper ground bars together using solid copper splice plates supplied by the ground bar manufacturer.
   2. Bond together nonadjacent ground bars on equipment racks and cabinets with 16 mm² (6 AWG) insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
   3. Provide a 16 mm² (6 AWG) bonding jumper between the rack and/or cabinet ground bus bar and the aluminum pan of an overhead cable tray or the raised floor stringer as appropriate.

D. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near the top of backboards used for communications cross-connect systems. Connect backboard ground terminals to the aluminum pan in the telephone-type cable tray using an insulated 16 mm² (16 AWG) bonding jumper.

E. Other Communication Room Ground Systems: Ground all metallic conduit, wire ways, and other metallic equipment located away from equipment racks or cabinets to the cable tray pan or the telecommunications ground bus bar, whichever is closer, using insulated 16 mm² (6 AWG) ground wire bonding jumpers.

3.6 COMMUNICATIONS CABLE GROUNDING

A. Bond all metallic cable sheaths in multi-pair communications cables together at each splicing and/or terminating location to provide 100 percent metallic sheath continuity throughout the communications distribution system.
   1. At terminal points, install a cable shield bonding connector provide a screw stud connection for ground wire. Use a bonding jumper to connect the cable shield connector to an appropriate ground source like the rack or cabinet ground bar.
   2. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or the splice case grounding and bonding accessories provided by the splice.
case manufacturer. When an external ground connection is provided as part of splice closure, connect to an approved ground source and all other metallic components and equipment at that location.

3.7 COMMUNICATIONS CABLE TRAY SYSTEMS

A. Bond the metallic structures of one cable tray in each tray run following the same path to provide 100 percent electrical continuity throughout this cable tray systems as follows:

1. Splice plates provided by the cable tray manufacturer can be used for providing a ground bonding connection between cable tray sections when the resistance across a bolted connection is 10 milliohms or less. The contractor shall verify this loss by testing across one splice plate connection in the presence of the Engineer.
2. Install a 16 mm² (6 AWG) bonding jumper across each cable tray splice or junction where splice plates cannot be used.
3. When cable tray terminations to cable rack, install 16 mm² (6 AWG) bonding jumper between cable tray and cable rank pan.

3.8 WIREWAY GROUNDING

A. Ground and Bond Metallic Wire way Systems as follows:

1. Bond the metallic structures of wire way to provide 100 percent electrical continuity throughout the wire way system by connecting a 16 mm² (6 AWG) bonding jumper at all intermediate metallic enclosures and across all section junctions.
2. Install insulated 16 mm² (6 AWG) bonding jumpers between the wire way system bonded as required in paragraph 1 above, and the closest building ground at each end and approximately every 16 meters (50 feet).
3. Use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wire way at each end at all intermediate metallic enclosures and cross all section junctions.
4. Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 meters.

3.9 COMMUNICATIONS RACEWAY GROUNDING

A. Conduit: Use insulated 16 mm² (6 AWG) bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.

B. Wire way: Use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wire way at each end at all intermediate metallic enclosures and across all section junctions.

C. Cable Tray Systems: Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 16 meters (50 feet).
3.10 GROUND RESISTANCE

A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.

B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

C. Services at power company interface points shall comply with the power company ground resistance requirements.

D. Below-grade connections shall be visually inspected by the Resident Engineer prior to backfilling. The Contractor shall notify the Resident Engineer 24 hours before the connections are ready for inspection.

3.11 GROUNDING FOR RF/EMI CONTROL

A. Install bonding jumpers to bond all conduit, cable trays, sleeves, and equipment for low voltage signaling and data communications circuits. Bonding jumpers shall consist of 100 mm (4 inches) wide copper strip or two 6 mm² (10 AWG) copper conductors spaced minimum 100 mm (4 inches) apart. Use 16 mm² (6 AWG) copper where exposed and subject to damage.

B. Comply with the following when shielded cable is used for data circuits.

1. Shields shall be continuous throughout each circuit.
2. Connect shield drain wires together at each circuit connection point and insulate from ground. Do not ground the shield.
3. Do not connect shields from different circuits together.
4. Shield shall be connected at one end only. Connect shield to signal reference at the origin of the circuit. Consult with equipment manufacturer to determine signal reference.

END OF SECTION 27 0526
SECTION 27 0528 - CABLE TRAYS FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 27 Sections apply to this section:

1. Basic Communication System Requirements.
2. Common Work Results for Communication.

1.2 SUMMARY

A. This section includes metallic cable trays. Types of cable trays in this section include the following:

1. Wire Basket Type.
2. Solid Bottom with Louvered Cover.

1.3 DEFINITIONS

A. Refer to NEMA Standard VE 1 for definitions of cable tray terminology used in this section.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

B. Product Data for wire basket tray products.

C. Shop Drawings: Layout floor plans and elevations showing cable tray system. Designate components and accessories including clamps, dividers, brackets, hanger rods, splice plates connectors, expansion joint assemblies, straight lengths, and fittings. Show accurately scaled components and spatial relationships to adjacent equipment. Show tray types, dimensions, and finishes.

D. Factory Test Reports: Certified copies of factory test reports performed in conformance with NEMA Standard VE 1 on wire basket trays of types and size specified for this project.
1.5 QUALITY ASSURANCE

A. Manufacturer: Firms regularly engaged in the manufacture of wire basket trays whose products have been in satisfactory use in similar service for not less than 5 years.

B. UL and NEMA Compliance: Wire basket trays and components shall be listed and labeled by UL and comply with NEMA Standard VE 1, "Cable Tray Systems."

C. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

D. Single-Source Responsibility: All wire basket tray components shall be the product of a single manufacturer.

E. Coordination Drawings: Include wire basket tray systems in coordination drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. T. J. Cope
2. B-Line Systems, Inc.
3. Cablofil
4. Mono-Systems

2.2 CABLE TRAYS, GENERAL REQUIREMENTS

A. Wire basket and solid bottom/top tray systems shall be of indicated types, sizes, and NEMA classes and shall be complete with manufacturer's recommended covers, barrier strips, dropouts, fittings, conduit adapters, hold-down devices, grommets, and blind ends as required and indicated.

B. Wire basket tray products shall have rounded edges and smooth surfaces.

C. Wire basket trays shall be manufactured from high strength steel wires. Wire to be welded, formed, and coated after fabrication.

D. Straight section to be provided in 10’ sections.

2.3 MATERIALS AND FINISHES

A. Wire Basket Trays, Fittings, and Accessories: Carbon Steel.

B. Wire Basket Trays, Fittings, and Accessories: Hot Dip Galvanized Finish. Hot dip galvanizing to be applied to welded and formed wire mesh surfaces.
C. Minimum Tray Bending Radius: 12 inches.

2.4 SIZES AND CONFIGURATIONS

A. Wire Basket Tray Mesh Opening: 4” x 2”
B. Wire Basket Side Rail Depth: 4 inches.
C. Wire Basket Tray Width: As noted on drawings.
D. Solid-Bottom Type Trays Nominal Side-Rail Load Depth: 4 inches.

2.5 CABLE TRAY ACCESSORIES

A. Barrier Strips: Minimum two continuous full height dividers to separate wiring of the various systems. Same materials and finishes as wire basket trays.
B. Covers: Louvered type, of same materials and finishes as cable trays.

2.6 SUPPORTS AND CONNECTORS

A. Wire basket tray supports and connectors, including bonding jumpers shall be as recommended by wire basket tray manufacturer.
B. Supports shall be spaced a maximum of 5' on center and at all change of directions.
C. Wire basket tray support system shall be installed at manufacturer’s suggested support span of 5’ at a span load of L/300.
D. Solid Bottom cable tray support system shall support a working load of 100 lbs. per linear foot, evenly distributed, with a maximum deflection of .62” when supported 10’ on centers and have a safety factor of 1.5. Where cable trays are installed above finished ceiling, the Contractor shall install the cable tray such that the maximum deflection, as stated for the above loading, does not interfere with the ceiling system.

2.7 FASTENERS FOR SUPPORTS

A. Fasteners to connect wire basket tray supports to the building structure shall be as follows:
   1. Expansion Anchors: Carbon steel wedge or sleeve type.
   2. Toggle Bolts: All steel springhead type.
2.8  **FIRE STOPPING**

A. General: Materials shall be UL listed and labeled and FM approved for fire ratings consistent with penetrated barriers.

B. Sleeves: Schedule 40, welded, black steel pipe sleeves. Sizes as indicated or minimum NEC size for cable or cable group to be installed.

C. Sealing Fittings: Suitable for sealing cables in sleeves or core drilled holes.

D. Sealing Mortar: Suitable for sealing cable penetration slots/openings in fire barriers.

E. Sealant: One-part compound for sealing cables, sleeves, and openings in fire barriers.

F. Two-Part Sealant: Formed-in-place sealant as specified in Division 26 Section 26 0500 Common Work Results for Electrical.

2.9  **WARNING SIGNS**

A. Lettering: 1-1/2-inch high, black on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and Fastening: Conform to Section "Electrical Identification."

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PART 3 - EXECUTION

3.1  **INSPECTION**

A. Examine areas and conditions under which the wire basket trays are to be installed, coordinate locations with all other Contractors and light fixtures. The exact location will be as directed by Owner/Architect. Provide all necessary steel supports, hanger rods, and miscellaneous hardware. Provide all necessary horizontal and vertical offsets to complete the installation around obstacles, building structure, and other systems.

3.2  **INSTALLATION OF CABLE TRAY SYSTEMS**

A. Wire basket tray shall be installed with a minimum 18" clearance from light fixtures, electrically operated equipment and all wiring operating at 120 or more volts.

B. Install cable trays in accordance with equipment manufacturer's written instructions.

C. Remove burrs and sharp edges of wire basket trays.

D. Support cable trays independently from the building structural components.

E. Conform to manufacturer's recommendations for selection and installation of supports.
F. Support Locations: Locate supports in accordance with the recommendations of the wire basket tray manufacturer.

G. Installation of supports shall be in accordance with wire basket tray manufacturer's written instructions and the recommendations of Paragraph 6.5 of NEMA Standard VE 1.

H. Fastening Supports: Unless otherwise indicated, fasten cable tray supports securely to the building structure as specified in Division 26 Section Hangers and Supports for Electrical Systems.

I. Support at Connections to Equipment: Where wire basket trays connect to equipment, provide flanged fittings fastened to the tray and to the equipment. Support the tray separately. Do not carry the weight of the tray on the equipment enclosure.

J. Thermal Contraction and Expansion: Install expansion connectors in wire basket tray runs as recommended by the manufacturer.

K. Direction Changes: All bends, intersections, elevation changes, reducers, etc., are to be field fabricated utilizing straight sections, hardware, and instructions provided by the manufacturer.

L. Locate wire basket tray above piping except as required for tray accessibility and as otherwise indicated.

M. Firestopping: Where wire basket trays penetrate fire and smoke barriers including walls, partitions, floors, and ceilings, install fire-stopping at penetrations after cables are installed.

N. Sleeves For Future Cables: Install capped sleeves for future cables through firestopped wire basket tray penetrations of fire/smoke barriers.

O. Working Space: Install wire basket trays with sufficient space to permit access for installing cables.

P. Barriers: Where trays carry conductors of different systems, such as television, communications, and data processing, install barriers to separate the systems.

3.3 GROUNDING

A. Electrically ground wire basket trays and ensure continuous electrical conductivity of wire basket tray system. Use tray as an equipment ground conductor for itself only, not for connected equipment.

3.4 WARNING SIGNS

A. After installation of wire basket trays is completed, install warning signs, on or in proximity to wire basket trays, where easily seen by occupants of space.
3.5 FIELD TESTING

A. Grounding: Test wire basket trays to ensure electrical continuity of bonding and grounding connections.

B. Anchorage: Test pull-out resistance of one of each type, size, and anchorage material for toggle bolts and powder-driven threaded studs.

C. Furnish equipment, including jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the Architect's approval before transmitting loads to the structure. Test to 90 percent of rated proof-load for fastener. If fastening fails test, replace fastener and retest until satisfactory results are achieved.

3.6 CLEANING AND FINISH REPAIR

A. Upon completion of installation of wire basket trays, inspect trays, fittings, and accessories. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

B. Galvanized Finish: Repair damage with a zinc-rich paint recommended by the tray manufacturer.

END OF SECTION 27 0528
SECTION 27 0529 - HANGERS AND SUPPORTS FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Requirements of the following Division 27 Sections apply to this section:
   1. Division 27 Section 27 0100: “Basic Communication Systems Requirements”.
   2. Division 27 Section 27 0500: “Common Work Results for Communications”.

1.2 SUMMARY

A. This Section includes secure support from the building structure for communication items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. All supports shall utilize threaded fasteners for all connections/attachments. The use of clips or clip-on type supports is not acceptable.

C. Types of supports, anchors, sleeves, and seals specified in this section include the following:
   1. Clevis hangers
   2. Riser clamps
   3. C-clamps
   4. I-beam clamps
   5. Conduit straps
   6. Round steel rods
   7. Lead expansion anchors
   8. Toggle bolts
   9. Wall and floor seals

D. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly in other Division-27 sections.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve, and seal.

C. Shop Drawings: Submit dimensioned drawings of fabricated products, indicating details of fabrication and materials.
1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing supporting device work similar to that required for this project.

C. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of supporting devices.

D. MSS Compliance: Comply with applicable MSS standard requirements pertaining to fabrication and installation practices for pipe hangers and supports.

E. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

F. UL Compliance: Provide components that are UL listed and labeled.

G. FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe, and cable.

H. Components shall be listed and labeled by ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Slotted Metal Angle and U-Channel Systems:
   a. Allied Tube & Conduit
   b. American Electric
   c. B-Line Systems, Inc.
   d. Cinch Clamp Company, Inc.
   e. Elcen Metal Products Company
   g. Haydon Corporation
   h. Kin-Line, Inc.
   i. Midland-Ross Corporation
   j. Power-Strut Div; Van Huffel Tube Corporation
   k. Unistrut Diversified Products

2. Anchors:
   a. Abbeon Cal Inc.
b. Ackerman Johnson Fastening Systems Inc.
c. Elen Metal Products Company
d. Ideal Industries, Inc.
e. Joslyn Mfg and Supply Company
f. McGraw Edison Company
g. Rawl Plug Company Inc.
h. Star Expansion Company
i. U.S. Expansion Bolt Company
j. Hilti, INC.

2.2 U-CHANNEL STRUT SYSTEMS

A. Provide U-channel strut system for supporting communication equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" diameter holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U-channel and are of the same manufacturer:

1. Fixture hangers
2. Channel hangers
3. End caps
4. Beam clamps
5. Wiring stud
6. Thin wall conduit clamps
7. Rigid conduit clamps
8. Conduit hangers
9. U-bolts

2.3 SUPPORTING DEVICES

A. Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

1. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 1/2" diameter hole for round steel rod; approximately 54 pounds per 100 units.
2. Riser Clamps: For supporting 5" rigid metal conduit; black steel; with 2 bolts and nuts; and 4" ears; approximately 510 pounds per 100 units.
3. Reducing Couplings: Steel rod reducing coupling 1/2" x 5/8"; black steel; approximately 16 pounds per 100 units.
4. C-Clamps: Black malleable iron; 1/2" rod size' approximately 70 pounds per 100 units.
5. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock, 3/8" cross bolt; flange width 2"; approximately 52 pounds per 100 units.
6. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approximately 7 pounds per 100 units.
7. Two-Hole Conduit Straps: For supporting 3/4" rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
8. Hexagon Nuts: For 1/2" rod size; galvanized steel; approximately 4 pounds per 100 units.
9. Round Steel Rod: Black steel; 1/2" diameter; approximately 67 pounds per 100 feet.
10. Offset Conduit Clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 pounds per 100 units.

2.4 ANCHORS

A. Provide anchors of types, sizes and materials indicated; and having the following construction features:

1. Lead Expansion Anchors: 1/2", approximately 38 pounds per 100 units.
2. Toggle Bolts: Springhead; 3/16" x 4"; approximately 5 pounds per 100 units.

2.5 SLEEVES AND SEALS

A. Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:

1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

2.6 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.7 FABRICATED SUPPORTING DEVICES

A. General: Shop or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide supporting devices that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Contractor’s option.
B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installations of supporting devices.

C. Coordinate with the building structural system and electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

D. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

E. Obtain approval from the Architect before drilling or cutting structural members.

F. Install surface-mounted cabinets with minimum of four anchors.

3.2 MISCELLANEOUS SUPPORTS

A. Support miscellaneous components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, boxes, and other devices.

3.3 FASTENING

A. Unless otherwise indicated, fasten items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, boxes, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts, or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

2. Holes cut into reinforced concrete beams or in concrete shall not cut reinforcing bars. If the Contractor cuts into any reinforcing bars, stop work and notify the Architect immediately. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

3.4 TESTS

A. Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors.
2. Toggle bolts.
B. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

END OF SECTION 27 0529
SECTION 27 0534 - BOXES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Requirements of the following Division 27 Sections apply to this section:

1. Division 27 Section 27 0100 “Basic Communication Systems Requirements”.
2. Division 27 Section 27 0500 “Common Work Results for Communications”.

1.2 SUMMARY

A. This section includes boxes and fittings for communication installations and certain types of electrical fittings not covered in other sections. Types of products specified in this Section include:

1. Outlet and device boxes.

B. In general, all outlet boxes, conduit and raceway shall be provided by the Division 26 Electrical Contractor. The Communication Contractor shall provide any miscellaneous outlet boxes, conduit and raceway at the communication system racks only. The outlet boxes, conduit and raceway provided by the Communication Contractor shall supplement that provided by the EC in order to accomplish a neat and orderly installation.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections:

1.4 QUALITY ASSURANCE

A. Nationally Recognized Testing Laboratory Listing and Labeling (NRTL): Items provided under this section shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

B. National Electrical Code Compliance: Components and installation shall comply with NFPA 70 "National Electrical Code."

C. UL Compliance: Comply with applicable requirements of UL 50, UL 514 Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings that are UL listed and labeled.
D. NEMA Compliance: Comply with applicable requirements of NEMA Standards/Pub No.'s 0S1, 0S2 and Pub 250 pertaining to outlet and device boxes, covers and box supports.

E. Federal Specification Compliance: Comply with applicable requirements of FS W-C-586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps".

PART 2 - PRODUCTS

2.1 BOXES AND FITTINGS - GENERAL

A. Provide electrical boxes, and fittings of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

2.2 OUTLET AND DEVICE BOXES

A. Outlet Boxes: Provide galvanized flat rolled sheet steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Provide outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

B. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.

C. Manufacturers: Subject to compliance with requirements, provide interior outlet boxes of one of the following:

1. American Electric
2. Appleton Electric; Emerson Electric Company
3. Bell Electric; Square D Company
5. Midland-Ross Corporation
6. OZ/Gedney; General Signal Company
7. Thepitt
8. Hubbell, Inc.
9. Thomas & Betts Company
10. Pass and Seymour, Inc.
2.3 BUSHINGS, KNOCKOUT CLOSURES, AND LOCKNUTS

A. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts, malleable iron conduit bushings, offset connectors of types and sizes to suit respective installation requirements and applications.

B. Manufacturers: Subject to compliance with requirements, provide bushings, knockout closures, locknuts and connectors of one of the following:

1. Adalet-PLM Div; Scott Fetzer Company
2. AMP, Inc.
3. Arrow-Hart Div; Crouse-Hinds Company
4. Appleton Electric Company; Emerson Electric Company
5. Midland-Ross Corporation
6. Midwest Electric; Cooper Industries Inc.
7. OZ/Gedney Company; General Signal Company
8. RACO Div; Harvey Hubbell Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: The Electrical Contractor shall provide all junction boxes for communication devices in walls and floors. The Communication Contractor shall provide any miscellaneous junction boxes required for a neat and complete installation.

B. Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation" and in accordance with recognized industry practices to fulfill project requirements.

C. Locations:

1. Install items where required to suit code requirements and installation conditions.
2. Locate and install boxes to allow access. Where installation is otherwise inaccessible, coordinate locations and sizes and provide required access doors.
3. Locate and install to maintain headroom and to present a neat appearance.
4. Position recessed outlet boxes accurately to allow for surface finish thickness.

D. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or busing on rounded surfaces.

1. Provide electrical connections for installed boxes.
2. Subsequent to installation of boxes, protect boxes from construction debris and damage.
3. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
4. Support and fasten items securely in accordance with Division 27 Section "Hangers and Supports for Communication Systems."
5. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.
6. Remove sharp edges where they may come in contact with wiring or personnel.

3.2 GROUNDING

A. Electrically ground metallic boxes and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the box or enclosure.

3.3 CLEANING AND FINISH REPAIR

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions, and weld marks.

B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the manufacturer.

C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating recommended by the manufacturer.

END OF SECTION 27 0534
SECTION 27 0553 - IDENTIFICATION FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Requirements of the following Division 27 Sections apply to this section:
   1. Division 27 Section 27 0100 “Basic Communication System Requirements”.
   2. Division 27 Section 27 0500 “Common Work Results for Communications”.

1.2 SUMMARY
A. This Section includes identification of communication cables, equipment, and installations. It includes requirements for identification components including but not limited to the following:
   1. Identification labeling for cables.
   2. Operational instruction signs.
   3. Equipment labels and signs.
B. Refer to Division-01 General Requirements Section, "Identification Systems" for equipment and system nameplates, and performance data; not work of this section.
C. Refer to other Division 27 sections for additional specific identification requirements associated with specific items.

1.3 SUBMITTALS
A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
B. Product Data: Manufacturer's data for each type of product specified.
C. Schedule of identification nomenclature to be used for identification signs and labels.
D. Samples of each color, lettering style, and other graphic representation required for identification materials; samples of labels and signs.

1.4 QUALITY ASSURANCE
A. Manufacturers: Firms regularly engaged in manufacture of electrical or communication identification products of types required, whose products have been in satisfactory use in similar service for not less than 3 years.
B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing identification work similar to that required for this project.

C. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

D. UL Compliance: Comply with applicable requirements of UL Standard 969, "Marking and Labeling Systems", pertaining to identification systems.

E. ANSI Compliance: Comply with applicable requirements of ANSI Standard A13.1 "Scheme for the Identification of Piping Systems", with regard to type and size of lettering for cable labels.

F. NEMA Compliance: Comply with applicable requirements of NEMA Standard No's. WC-1 and WC-2 pertaining to identification of control conductors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following (for each type marker):

1. Ideal Industries, Inc.
2. Panduit Corporation
3. Seton Name Plate Company

2.2 ELECTRICAL IDENTIFICATION PRODUCTS

A. Adhesive Marking Labels for Raceway and Metal-clad Cable: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service (Communications, Control, etc.).

1. Label Size: as follows:

   b. Raceways Larger than 1-Inch: 1-1/8 inches high by 8 inches long.

B. Cable Identification Bands:

1. General: Provide manufacturer's standard plastic wrap-around cable markers, of size required for proper application, and numbered to show cable identification.

C. Equipment Labels

1. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening.
2. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.

D. Lettering and Graphics

1. General: Coordinate names, abbreviations and other designations used in identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

E. Fasteners for Plastic-Laminated and Metal Signs

1. Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers. Exception: Where specifically approved contact type permanent adhesive may be used in areas where screws cannot or should not penetrate substrate.

PART 3 - EXECUTION

3.1 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

B. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.

C. Install identification devices as indicated, in accordance with manufacturer's written instructions and requirements of NEC.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Regulations: Comply with governing regulations and requests of governing authorities for the identification of work.

3.2 CABLE IDENTIFICATION

A. Apply cable identification on each voice/data cable in each rack/cabinet and for all sound system cabling and cable television cabling. Match identification with marking system used on shop drawings, contract documents, and similar previously established identification for project's work.

B. Each cable shall be marked at both ends. For local area network, each patch cable or cross connect cable shall be marked at both ends.
C. The Contractor shall review the identification scheme with the Owner prior to commencing work. The identification scheme shown on the floor plans is based on architectural room numbers and may not necessarily be the final post-construction room numbers.

3.3 OUTLET LABEL
A. For the tele/data cabling, provide labels for each data outlet, using faceplate manufacturer’s standard label holder and recommendations of TIA/EIA.

3.4 OPERATION SIGNS
A. Provide instruction signs with approved legend where instructions or explanations are needed for system or equipment operation.

3.5 INSTALLATION
A. Provide equipment identification labels of engraved plastic-laminate on each major unit of communication equipment in the building, including each rack, cabinet and main network switch, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 1/2-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), white lettering in black field. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each communication system component.

1. TV/audio-monitoring master station.
2. Clock/program master equipment.
3. Call system master station.

B. Provide labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

END OF SECTION 27 0553
SECTION 27 0800 - COMMISSIONING OF COMMUNICATIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Section Includes: Testing of Telecommunications Backbone and Horizontal Cabling subsystems.

B. Related Sections

1. Consult all other Sections and Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to completely test a complete and operable system.

2. Section 27 0100: Basic Telecommunications Requirements

3. Section 27 1300: Communications Backbone Cabling

4. Section 27 1500: Copper Cabling Systems

C. Products Furnished and Installed Under Other Sections:

1. Telecommunications Cabling

1.2 REFERENCES

A. Comply with Section 27 0100 References requirements.

B. Additional references to those listed in Section 27 01 00.

1. TIA/EIA-526-14 (“OFSTP-14”) Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.

2. TIA/EIA-526-7 (“OFSTP-7”) Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant

3. TIA/EIA-455-171 Attenuation By Substitution Measurement – For Short-Length Multimode Graded-Index And Single-Mode Optical Fiber Cable Assemblies (a.k.a., FOTP-171)

1.3 DEFINITIONS

A. Refer to Definitions of Sections 27 0100, 27 13 00 and 27 15 00.

B. In addition, the following list of terms as used in this specification shall be defined as follows:

1. “Adapter” (associated with fiber connectivity): Shall mean a connecting device joining 2 fiber connectors, either like or unlike.

2. “Channel”: Shall mean a testing configuration which includes the Permanent Link and the line cord (at the workstation), the equipment cord, and, if a full cross connection is implemented, a patch cord and the cross connect termination/connecting apparatus.
3. “Connect”: Shall mean install all required patch cords, equipment cords, cross-connect wire, etc. to complete an electrical or optical circuit.

4. “Cord”: Shall mean a length of cordage having connectors at each end. The term “Cord” shall be synonymous with the term “Jumper”. The cord may be:

   a. Unshielded twisted pair
   b. Fiber (multimode or singlemode), jacketed & buffered

5. “Launch Cord”: Shall mean the cord certified for use in fiber optic characterization testing, as described in this section.


7. “Passive Link Segment”: Shall mean the cable, connectors, couplings, and splices between two fiber optic termination units.

8. “Permanent Link”: Shall mean the ‘permanent’ portion of the Horizontal cabling to each outlet with the test cords de-embedded from the measurements; this includes cable, consolidation point (if used), termination/connecting apparatus in the IDF and the connector at the outlet.

9. “System Cord”: Shall mean the cord used in the operating electrical or optical circuit.

10. “Test Cord”: Shall mean the cord certified for use in testing, as described in this section.

1.4 SYSTEM DESCRIPTION

A. Work Provided Under Other Sections

1. Refer to Section 27 13 00 for a more complete System Description.

2. Backbone Cabling

   a. The Backbone Cabling includes twisted pair and fiber cabling.

3. Horizontal Cabling

   a. The Horizontal Cabling, in general, consists of multiple 4-pair Category 6 UTP cables to each outlet. Refer to the Drawings for specific requirements.

B. Base Bid Work

1. Testing of a completed Telecommunications Cabling System, including:

   a. Procedures Submittals.
   b. Equipment Submittals.

2. Testing Requirements:

   a. Fiber optic passive link segment(s):

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Type</th>
<th>Test</th>
<th>Direction</th>
<th>Wavelength</th>
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<td>Characterization</td>
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<td>850nm and 1300nm</td>
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<tr>
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<td>Single-</td>
<td>Characterization</td>
<td>Both</td>
<td>1310nm and</td>
</tr>
</tbody>
</table>
mode | Backbone | Multimode | Passive Link Ins. Loss | One | 850nm and 1300nm
---|---|---|---|---|---
Backbone | Single-mode | Passive Link Ins. Loss | One | 1310nm and 1550nm

b. Multipair/UTP cabling:
Table 270800-1.2: Tests For Multipair/UTP Cabling

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<thead>
<tr>
<th>Subsystem</th>
<th>Type</th>
<th>Test</th>
<th>Configuration</th>
<th>Notes</th>
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<td>Category 6</td>
<td>Permanent Link</td>
<td>Per TIA/EIA-568-B.2-1</td>
</tr>
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</table>

c. Record Documents, including test reports.

1.5 SUBMITTALS

A. Refer to Submittals of to Section 27 01 00 for procedural, quantity, and format requirements.

B. Preconstruction Submittal Requirements:

2. Product Submittal, including cut sheets of testing equipment to be used (note all software/firmware versions as applicable) and certificate of last calibration.
3. Schedule Submittal, consisting of proposed schedule of work. This schedule may be combined with the schedule developed for 27 XX XX series Sections.

C. Submittal Requirements at Closeout:

1. Record Documents.

D. Submittal Description: Record Documents

1. Test Reports: Record documents submittal shall include test reports showing the following information:

a. A title page which includes:

1) Client Name
2) Project Name
3) Project Address
4) General Contractor name / Telecommunications Installer name
5) Date of Submittal

b. Individual tabs which break down the test results by building, and then by telecommunications room.
c. All Backbone Fiber Optic “Post Installation” Passive Link Attenuation test results (utilize the forms provided in Part 4 of this specification for documentation of test results if the tester used does not have data storage capabilities) and Fiber Optic OTDR test results.
d. All Backbone UTP test results.
e. All Horizontal cable test results, per cable

2. Furnish all test results on CD-ROM in their native data format and an exported Microsoft Excel compatible format.
   a. Include all necessary software to allow viewing and printing of individual test results.
b. CD shall be labeled with the project name, contractor name, and date of submission.

1.6 QUALITY ASSURANCE
   A. Comply with the Quality Assurance requirements of Section 27 01 00.

1.7 WARRANTY
   A. Warrant the validity of the test results. Under no circumstances shall any cable’s test results be substituted for another’s. If a single instance of falsification is confirmed, the Contractor shall be liable for a complete retest of the cabling system at no additional cost to the Owner. This includes the retaining the services of a neutral party to observe all retesting.

PART 2 - PRODUCTS

2.1 GENERAL
   A. The manufacturer may change the product numbers listed in this Section at any time, as well as software and firmware versions. In the event this Section contains an invalid product number or conflicts with the written description, or specifies an out-of-date software and/or firmware version, notify the Engineer in writing prior to issuing submittals or field testing.

2.2 FIBER OPTIC LIGHT SOURCE
   A. All connection interfaces shall be factory installed. No field-configurable adapters will be allowed at the light source.
   B. Wavelengths output shall be continuous.
   C. LED-based light source for multimode fiber testing shall have a:
      1. Center wavelength of 850nm ± 30nm and 1300n ± 20nm.
      2. Spectral width (FWHM) 30nm - 60nm at 850nm and 100nm - 140nm at 1300nm.
      3. Minimum output power level of ≥14dBm.
D. VCSEL-based light source for multimode fiber testing shall have a:

1. Center wavelength of 850nm ± 30nm and 1300n ± 20nm.
2. Spectral width (FWHM) 30nm - 60nm at 850nm and 100nm - 140nm at 1300nm.
3. Minimum output power level of ≥14dBm.

E. LASER-based light source for single mode fiber testing shall have a:

1. Center wavelength of 1310n ± 20nm and 1550n ± 20nm.
2. Spectral width (FWHM) of ≤5nm at 1310nm and ≤5nm at 1550nm.
3. Minimum output power level of ≥3dBm.

F. The light sources may contain internal lenses, pigtails, and modal conditioners, provided they meet the launch conditions as described in "Post-Installation" Passive Link Attenuation Testing Procedures (ref. PART 3 - EXECUTION).

G. Equipment shall be factory-calibrated within 12 months of testing date.

H. Equipment:

1. Agilent Technologies’ WireScope 350 test set
   a. #450-1070 Fiber SmartProbe testing adapter, multimode 850nm.
   b. #450-1080 Fiber SmartProbe testing adapter, multimode 1300nm.
   c. #450-2020 Fiber SmartProbe testing adapter, singlemode 1300nm.
   d. ScopeData management software (version 5.20 or higher).

2. Corning Cable Systems
   a. #OS-301 light source
   b. #OS-302 light source
   c. #OS-100D light source

3. Fluke Networks’ DSP-4300 test set
   a. #DSP-4300; “CableAnalyzer” test kit, loaded with firmware version 3.0.4.
   b. #DSP-FTA420S; ‘Multimode’ fiber testing adapter, LED-based (850nm, 1300nm).
   c. #DSP-FTA430S; ‘Singlemode’ fiber testing adapter, LASER-based (1310nm, 1550nm).
   d. #DSP-FTA440S; ‘Gigabit’ fiber testing adapter, VCSEL-based (multimode @ 850nm and singlemode @ 1310nm).
   e. LinkWare; “LinkWare” management software (latest version).

4. Laser Precision #5150 test set

2.3 FIBER OPTIC POWER METER

A. The power meter for both multimode and singlemode testing must be capable of measuring relative or absolute power, and must be independent of modal distributions.
B. All power meters used must be calibrated and traceable to the National Bureau of Standards.

C. All power meters used shall have the following performance:
   1. Dynamic range of 0dBm to -40dBm, minimum.
   2. Accuracy of ±0.2dB.

D. Equipment shall be factory-calibrated within 12 months of testing date.

E. Equipment:
   1. Agilent Technologies’ WireScope 350 test set
      a. #450-1070 Fiber SmartProbe testing adapter, multimode 850nm.
      b. #450-1080 Fiber SmartProbe testing adapter, multimode 1300nm.
      c. #450-2020 Fiber SmartProbe testing adapter, singlemode 1310nm.
      d. ScopeData management software (version 5.20).
   2. Corning Cable Systems,
      a. #OTS-210 power meter, with data storage capacity.
      b. #OTS-310 power meter, with data storage capacity.
   3. Laser Precision #5025 test set

2.4 FIBER OPTIC MANDREL

A. For jacketed (3.0 mm) fiber, mandrel diameter shall be 22 mm for 50/125 um fiber. For unjacketed buffered (0.9 mm) fiber, mandrel diameter shall be 25 mm for 50/125 um fiber.

B. Equipment: Fluke Networks

C. #NF-MANDREL-50; red mandrel for jacketed 50/125 um fiber

2.5 FIBER OPTIC OTDR

A. Multimode Source Module:

<table>
<thead>
<tr>
<th>Wavelength</th>
<th>Dynamic Range</th>
<th>Attenuation Deadzone</th>
<th>Reflective Deadzone</th>
<th>Loss Resolution</th>
<th>Distance Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>850nm</td>
<td>24dB</td>
<td>6.5mt</td>
<td>3.0mt</td>
<td>0.001dB</td>
<td>0.1mt</td>
</tr>
<tr>
<td>1300nm</td>
<td>27dB</td>
<td>7.0mt</td>
<td>3.0mt</td>
<td>0.001dB</td>
<td>0.1mt</td>
</tr>
</tbody>
</table>

B. Singlemode Source Module:

<table>
<thead>
<tr>
<th>Wavelength</th>
<th>Dynamic Range</th>
<th>Attenuation Deadzone</th>
<th>Reflective Deadzone</th>
<th>Loss Resolution</th>
<th>Distance Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1310nm</td>
<td>40dB</td>
<td>6.0mt</td>
<td>3.5mt</td>
<td>0.001dB</td>
<td>0.1mt</td>
</tr>
<tr>
<td>1550nm</td>
<td>28dB</td>
<td>12.0mt</td>
<td>3.5mt</td>
<td>0.001dB</td>
<td>0.1mt</td>
</tr>
</tbody>
</table>
C. Equipment, including main unit and source modules, shall be factory-calibrated within 12 months of testing date.

D. Equipment:

1. Agilent Technologies #8147, for multimode & singlemode systems
2. Corning Cable Systems
   a. 2001HR, for multimode & singlemode systems
   b. 340 OTDR Plus Multitester II
   c. MiniOTDR+, for multimode & singlemode systems
3. Tektronix
   a. TFP2A FiberMaster
   b. TFS3031 TekRanger2

2.6 FIBER OPTIC TEST CORDS

A. Multimode Fiber Optic Test Cord:

1. The fiber of the multimode test cord(s) shall have the core diameter and numerical aperture nominally equal to that of the multimode fiber optic passive link.
2. The length of test cords used for insertion loss testing shall be between 1m and 5m.
3. The connectors of the test cords shall be compatible with the connector types of the light source and the power meter.
   a. The connector of the test cords shall be that which the light source accepts.
4. The connectors shall exhibit <= 0.5dB loss per connection @ both 850nm and 1300nm, as measured per FOTP-171 D2.

B. Singlemode Fiber Optic Test Cord:

1. The fiber of the singlemode test cord(s) shall have the mode field diameter nominally equal to that of the singlemode fiber optic passive link.
2. The length of test cords used for insertion loss testing shall be between 1m and 5m.
3. The connectors of the test cords shall be compatible with the connector types of the light source and the power meter.
   a. The connector of the test cords shall be that which the light source accepts.
4. The connectors shall exhibit <= 0.5dB loss per connection @ both 1300nm and 1550nm, as measured per FOTP-171 D3.
5. All singlemode connectors shall inhibit Fresnel reflections (i.e., have a “PC” finish).

2.7 CATEGORY 6 HORIZONTAL CABLE TESTER

A. Equipment shall meet TIA/EIA-568B.2 Addendum 1 requirements for Level III accuracy.
B. Test Standards (minimum): TIA Category 6 (per TIA/EIA-568B.2 Addendum 1); ISO/IEC 11801 Class C and D; ISO/IEC 11801-2000 Class C and D, 1000Base-T, 100Base-TX; IEEE 802.3 10Base-T; ANSI TP-PMD; IEEE 802.5

C. Areas of Test Measurement (minimum): Wire Map; Length; Insertion Loss; Near End Crosstalk (NEXT) loss, at both master unit and remote unit; Power Sum NEXT (PSNEXT) loss, at both master unit and remote unit; Equal Level Far End Crosstalk (ELFEXT), at both master unit and remote unit; Power Sum ELFEXT, at both master unit and remote unit; Return Loss (RL), at both master unit and remote unit; Propagation Delay and Delay Skew; Attenuation-to-Crosstalk Ratio (ACR), at both master unit and remote unit; Power Sum ACR (PSACR), at both master unit and remote unit; Characteristic Impedance; DC Loop Resistance.

D. Equipment: Agilent Technologies
   1. #N2600A-100; “WireScope 350” test kit (main unit, remote unit, CAT6 permanent link probe, CAT6 channel probe, accessories), loaded with firmware version 3.1.1.
   2. “ScopeData Pro” reporting and documentation software latest version.

E. Equipment: Fluke Networks
   1. #DTX-1200 or #DTX-1800; “DTX CableAnalyzer” test kit (main unit, remote unit, CAT6 permanent link adapters, CAT6 channel adapters, accessories), loaded with latest version of firmware.
   2. #DSP-4300; “CableAnalyzer” test kit (main unit, remote unit, CAT6 permanent link adapters, CAT6 channel adapters, accessories), loaded with firmware version 3.0.4.
   3. “LinkWare” reporting and documentation software (version 1.1, or higher)

2.8 BACKBONE UTP CABLING TESTERS

A. Wire Map (continuity, opens, shorts, crossed pairs, split pairs) tester, or equal:
   1. Siemon #MT-5000 test unit, with 25-pair adapter.

B. Length tester, or equal:
   1. Harris #TS-90 test unit

PART 3 - EXECUTION

3.1 SCHEDULING

A. Schedule both the Engineer of Record and a representative of the test equipment manufacturer for a demonstration of testing methods. Execute a demonstration of testing methods with aforementioned parties prior to ‘production’ testing activities. Test reports and acceptance testing will not be accepted without proof of methods demonstration.
3.2 FIELD QUALITY CONTROL

A. Complete testing as delineated below prior to system acceptance.

B. Permanently record all test results and presented in a format acceptable to the Owner or Engineer before system acceptance.

C. Remove and replace with new, at no cost to the Owner, any cables or conductors (copper or glass) failing to meet the indicated standards. The Owner will not accept the installation until testing has indicated a 100% availability of all cables and conductors or the Owner has approved any deviation from this requirement.

D. Calibrate test sets and associated equipment per the manufacturers printed instructions at the beginning of each day’s testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.

3.3 "PRE-INSTALLATION" CONTINUITY TESTING PROCEDURES

A. Ensure fiber continuity of all fiber strands of all cables prior to installation.

B. Reports from “pre-installation” continuity testing are not required to be submitted at project close out.

3.4 BACKBONE FIBER OPTIC CHARACTERIZATION TESTING

A. Test fiber optic passive links per “Base Bid Requirements” in Part 1 of this Section.

B. Precautions:

1. Adhere to the equipment manufacturer’s instructions during testing activities.
2. Prior to any testing activity or any measurements taken, complete the following activities:
   a. Ensure the test equipment is at room temperature – approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for however long it takes to bring the test equipment to reach room temp).
   b. Clean all launch cords and system cords (if applicable) connectors and all adapters with a lint-free wipe and 90% (or higher) isopropyl alcohol.
3. Do not power off OTDR’s light source during testing activity.
4. Do not remove launch cord from the OTDR’s light source at any time (unless the testing is complete or the equipment is being put away for the evening, or during trouble shooting).
5. Do not bend the launch cord smaller than 20 times the cord diameter during testing activities (this may induce loss into the cord reducing the accuracy of the measurement).
6. Fully charge power source before each day’s testing activity, if applicable.

C. "Post-Installation" Characterization Testing Procedures

1. Equipment settings / measurement parameters:
a. Index of Refraction: match cable-under-test fiber parameters; default settings as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Brand</th>
<th>850nm</th>
<th>1300nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimode</td>
<td>Corning 50/125 Infinicor</td>
<td>1.483</td>
<td>1.483</td>
</tr>
<tr>
<td></td>
<td>SYSTIMAX 50/125</td>
<td>1.483</td>
<td>1.478</td>
</tr>
<tr>
<td>Singlemode</td>
<td>SYSTIMAX</td>
<td>1.466</td>
<td>1.467</td>
</tr>
<tr>
<td></td>
<td>Corning SMF-28</td>
<td>1.4675</td>
<td>1.4681</td>
</tr>
</tbody>
</table>

b. Pulse Width: multimode: 20ns; singlemode: 50 ns.

<table>
<thead>
<tr>
<th>Type</th>
<th>Length</th>
<th>Multimode:</th>
<th>Singlemode:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 ns for cable lengths up to 500 meters</td>
<td>20 ns for cable lengths from 250 meters to 2,000 meters</td>
<td>10 ns for cable lengths up to 2,000 meters</td>
</tr>
</tbody>
</table>


c. Backscatter:

1) Multimode: -67dB @ 850nm, -74dB @ 1300nm;
2) Singlemode: -74dB @ 1310nm and 1550nm

d. Event Threshold: 0.05dB for both multimode and singlemode

e. Reflection Threshold:

1) Multimode: -45dB
2) Singlemode: -60dB

a) Fiber Break/End-Of-Fiber: 3dB for both multimode and singlemode

2. Waveform: The waveform shall be real-time/normal density.
3. Obtain measurements using a ‘launch’ cord connected to the test instrument and the cable-under-test.

a. The fiber of the launch cord shall match the fiber of the cable-under-test in physical and performance parameters (such as type, core/cladding size, index of refraction, refractive profile). The fiber of the launch cord should match the fiber of the cable-under-test in manufacturer and product.

b. The length of the launch cord shall be between 25 meters and 100 meters.

4. Review the results of each test and bring to the attention of the Engineer all fibers that do not meet the manufacturer’s allowed loss for splices and connectors, or fibers that do not meet the length of the overall cable length.

D. Record Documents:

1. Test reports shall match the cable and fiber IDs as labeled in the field – i.e., the ID on the cable label/fiber port label shall be the same as what is associated with the electronic and printed test record.
2. The units for distance measurements (i.e., the “X” axis of the graph) shown on the print of the test measurements shall be feet.
3. For the traces, the x- and y-axis scales of a given cabling link shall be identical. Preferably, all reports shall be printed with identical scales on both x- and y-axis.
4. The launch cord must be shown in the trace of the printed test report.
5. Measurements shall carry a precision through one significant decimal place (minimum).
6. Each test report shall contain the following information (not necessarily in this order):
   a. Project name
   b. General Contractor name / Telecommunications Installer name
   c. Cable identifier, fiber number, and fiber type (e.g., “multimode”)
   d. Measurement direction,
   e. Date measurement was obtained,
   f. Operator (name an company),
   g. Test equipment model and serial number(s),
   h. Set up parameters (minimum - pulse width, refractive index, event threshold.)
   i. Wavelength,
   j. OTDR trace,
   k. Length of fiber,
   l. Overall link loss.
7. For each passive cabling link, include either a schematic graphic or narrative accurately describing the test set up as a preface to the test reports. In other words, show the launch cord with length, expected events with distances, etc. This information will eliminate many questions the Engineer will have while reviewing the reports.

3.5 Backbone fiber optic passive link Insertion Loss TESTING

A. Test fiber optic passive links per “Base Bid Requirements” in Part 1 of this Section.

B. Launch Conditions:
   1. For passive link insertion loss testing for multimode fibers, the modal launch condition from the light source shall be characterized as Category 1 per OFSTP-14.
   2. For passive link insertion loss testing of singlemode fibers:
      a. Use the launch conditions, as described in FOTP-78.
      b. Employ a method to remove high-order propagating modes, as described in FOTP-77.

C. Test Methods:
   1. The passive link insertion loss testing of multimode fibers shall be performed according to “Test Method B: One Jumper Reference”, per OFSTP-14, for ‘permanent’ links, and shall be performed according to “Test Method C: Three Jumper Reference”, per OFSTP-14, for ‘channel’ links.
   2. The passive link insertion loss testing of singlemode fibers shall be performed according to “Test Method A.1: One Jumper Measurement”, per OFSTP-7.

D. Precautions:
   1. Adhere to the equipment manufacturer’s instructions during testing activities.
2. Prior to any testing activity or any measurements taken:
   a. Ensure the test equipment is at room temperature – approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for about 15 minutes or for however long it takes to bring the test equipment to reach room temp).
   b. Power on the light source and power meter for at least 5 minutes.
   c. Clean all test cords & system cords (if applicable) connectors and all adapters with a lint-free wipe and 90% (or higher) isopropyl alcohol.

3. Do not power off light source or the power meter during testing activity.
4. Do not remove Test Cord #1 from the light source at any time (unless the testing is complete or the equipment is being put away for the evening).
5. Do not bend the test cords smaller than 20 times the cord diameter (this may induce loss into the cord reducing the accuracy of the measurement).
6. Fully charge power sources before each day’s testing activity.

E. Passive Link Insertion Loss Testing Procedures:

1. Test Equipment Set Up
   a. Follow the test equipment manufacturer’s initial adjustment and set up instructions.
   b. If the power meter has a Relative Power Measurement Mode, select this mode.
   c. If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.
   d. Set the light source and power meter to the same wavelength.

2. Test Cord Performance Verification
   a. Connect Test Cord #1 between the light source and the power meter.
   b. The value displayed on the power meter is the reference power ($P_{\text{ref}}$) measurement. If the power meter has a relative power measurement mode, enter this reference power measurement ($P_{\text{ref}}$) value into the meter. If it does not, hand-write $P_{\text{ref}}$ onto the record documents for future reference.
   c. Disconnect Test Cord #1 from the power meter. Do not disconnect Test Cord #1 from the light source.
   d. Connect the ‘open’ end of Test Cord #1 to an adapter (of matching connector type). Connect one end of Test Cord #2 to the adapter and the other end of Test Cord #2 to the power meter.
   e. The value displayed on the power meter is the power measurement ($P_{\text{sum}}$). If the power meter is in Relative Power Measurement Mode, the meter reading represents the test cord #2 connection attenuation. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the connection attenuation:

   1) If $P_{\text{sum}}$ and $P_{\text{ref}}$ are in the same logarithmic units (dBm, dBu, etc):
      \[
      \text{Connection Attenuation (dB)} = 10 \times \log_{10} \left( \frac{P_{\text{sum}} - P_{\text{ref}}}{P_{\text{ref}}} \right)
      \]

   2) If $P_{\text{sum}}$ and $P_{\text{ref}}$ are in watts:
      \[
      \text{Connection Attenuation (dB)} = 10 \times \log_{10} \left( \frac{P_{\text{sum}}}{P_{\text{ref}}} \right)
      \]
3) The measured connection attenuation must be less than or equal to the value found in Table 3 (below).

f. Flip the ends of Test Cord #2 so that the end connected to the power meter is now connected to the adapter, and the end connected to the adapter is now connected to the power meter.

g. The meter reading is the reversed Power Measurement ($P_{\text{sum}}$). Perform the proper calculations if not using Relative Power Measurement Mode.

h. Verify that both connection attenuation measurements are less than or equal to the value found in the following table:

<table>
<thead>
<tr>
<th></th>
<th>ST or SC Cord</th>
<th>Mini-Connector Cord</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimode (50/125)</td>
<td>0.50 dB Max</td>
<td>0.20 dB Max</td>
</tr>
<tr>
<td>Singlemode</td>
<td>0.55 dB Max</td>
<td>0.30 dB Max</td>
</tr>
</tbody>
</table>

i. If both measurements are found to be less than or equal to the values found in Table 1, test cord #1 is acceptable for testing purposes. Unacceptable attenuation measurements may be attributable to test cord #1 or test cord #2. Examine each cord with a portable microscope and clean, polish, or replace if necessary.

j. Repeat this test procedure from the beginning reversing the test cords in order to verify the performance of test cord #2.

3. Determine the Launch Category of the Light Source

a. The launch category of a light source can be determined by measuring its Coupled Power Ratio (CPR). The CPR is a measurement of the modal power distribution launched into a multimode fiber. A light source that launches a higher percentage of its power into the higher order modes of a multimode fiber produces a more over-filled condition and is classified as a lower Category than a light source that launches more of its power into just the lower order modes producing an under-filled condition. Under-filled conditions result in lower link attenuation, while over-filled conditions produce higher attenuation. Therefore, adjusting the acceptable link attenuation to compensate for a light source’s launch characteristics increases the accuracy of the test procedure.

b. Provide two test cords, one multimode (Test Cord #1) and one singlemode (Test Cord #2). Both cords shall be directly terminated on connectors that are compatible with the light source and power meter.

1) The fiber of the multimode test cord shall have the core diameter and numerical aperture nominally equal to those of the permanent link.

2) The fiber of the singlemode test cord shall contain Class IVa singlemode fiber, with a mode field diameter of $5.0 \pm 0.5 \, \mu m$ for 850nm tests and $9.0 \pm 1.0 \, \mu m$ for 1300nm tests.

c. Connect test cord #1 between the light source and the power meter. Avoid placing bends in the cord that are less than 4 inches in diameter.

d. The meter reading is the Reference Power Measurement ($P_{\text{ref}}$). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement ($P_{\text{ref}}$) value into the meter. If it does not, hand-write $P_{\text{ref}}$ for future reference.

e. Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
f. Connect test cord #2 between the power meter and test cord #1, using an appropriate adapter between the test cords.

1) Test cord #2, the singlemode cord, shall include a high order mode filter. This can be accomplished by twice wrapping the cord around a 1.2” diameter (30-mm) mandrel.


g. The meter reading is the Power Measurement ($P_{\text{sum}}$). If the power meter is in Relative Power Measurement Mode, the meter reading represents the CPR. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the CPR:

1) If $P_{\text{sum}}$ and $P_{\text{ref}}$ are in the same logarithmic units (dBm, dBu, etc): $\text{CPR (dB)} = \left| P_{\text{sum}} - P_{\text{ref}} \right|$

2) If $P_{\text{sum}}$ and $P_{\text{ref}}$ are in watts: $\text{CPR (dB)} = \left| 10 \times \log_{10} \left[ \frac{P_{\text{sum}}}{P_{\text{ref}}} \right] \right|$

Coupled Power Ratio (CPR) in dB, for 50/125μm Fiber:

<table>
<thead>
<tr>
<th></th>
<th>Cat-1 Over-filled</th>
<th>Cat-2</th>
<th>Cat-3</th>
<th>Cat-4</th>
<th>Cat-5 Under-filled</th>
</tr>
</thead>
<tbody>
<tr>
<td>850nm source</td>
<td>20 – 24</td>
<td>16 – 19.9</td>
<td>11 – 15.9</td>
<td>7 – 10.9</td>
<td>0 – 5.9</td>
</tr>
<tr>
<td>1300nm source</td>
<td>16 – 21</td>
<td>12 – 15.9</td>
<td>8 – 11.9</td>
<td>4 – 7.9</td>
<td>0 – 3.9</td>
</tr>
</tbody>
</table>

4. Multimode Insertion Loss Measurement

a. After setting up the test equipment, verifying the performance of the test cords, and determining the light source’s CPR, the insertion loss of the passive link segments can be measured.

b. Connect test cord #1 between the light source and the power meter.

c. The meter reading is the Reference Power Measurement ($P_{\text{ref}}$). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement ($P_{\text{ref}}$) value into the meter. If it does not, hand-write $P_{\text{ref}}$ for future reference and to be included in the Record Documents.

d. Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.

e. Connect test cord #1 to the passive link segment ‘input’.

f. At the opposite end of the passive link segment, connect test cord #2 to the link segment ‘input’ and the power meter.

g. The meter reading is the Power Measurement ($P_{\text{sum}}$). If the power meter is in Relative Power Measurement Mode, the meter reading represents the insertion loss. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the insertion loss:

1) If $P_{\text{sum}}$ and $P_{\text{ref}}$ are in the same logarithmic units (dBm, dBu, etc): $\text{Link Segment Attenuation (dB)} = \left| P_{\text{sum}} - P_{\text{ref}} \right|$

2) If $P_{\text{sum}}$ and $P_{\text{ref}}$ are in watts: $\text{Link Segment Attenuation (dB)} = \left| 10 \times \log_{10} \left[ \frac{P_{\text{sum}}}{P_{\text{ref}}} \right] \right|$

h. Record $P_{\text{sum}}$ for inclusion into the Record Documents. Refer to Records (ref. PART 3: EXECUTION) for all of the information to record.
5. Singlemode Insertion Loss Measurement
   a. After setting up the test equipment and verifying the performance of the test cords, the insertion loss of the passive link segments can be measured.
   b. Connect test cord #1 between the light source and the power meter.
   c. The meter reading is the Reference Power Measurement (P_{ref}). If the power meter has a Relative Power Measurement Mode, enter the Reference Power Measurement (P_{ref}) value into the meter. If it does not, hand-write P_{ref} for future reference and to be included in the Record Documents.
   d. Disconnect test cord #1 from the power meter. Do not disconnect test cord #1 from the light source.
   e. Connect test cord #1 to the passive link segment ‘input’.
   f. At the opposite end of the passive link segment, connect test cord #2 to the link segment ‘input’ and the power meter.
   g. The meter reading is the Power Measurement (P_{sum}). If the power meter is in Relative Power Measurement Mode, the meter reading represents the insertion loss. If the meter does not have a Relative Power Measurement Mode, perform the following calculation to determine the insertion loss:
      
      \[
      \text{Link Segment Attenuation (dB)} = \left| \frac{P_{sum}}{P_{ref}} - 1 \right|
      \]
      
      1) If P_{sum} and P_{ref} are in the same logarithmic units (dBm, dBu, etc): Link Segment Attenuation (dB) = \left| P_{sum} - P_{ref} \right|
      2) If P_{sum} and P_{ref} are in watts: Link Segment Attenuation (dB) = \left| 10 \times \log_{10} \left( \frac{P_{sum}}{P_{ref}} \right) \right|
   h. Record P_{sum} for inclusion into the Record Documents. Refer to Records (ref. PART 3: EXECUTION) for all of the information to record.

6. Acceptable Measurement Values
   a. Any cabling links failing to meet the criteria described in this specification shall be removed and replaced, at no cost to the Owner, with cables that prove, in testing, to meet the minimum requirements.
   b. The general insertion loss equation for any link segment is as follows:
      
      1) Insertion loss = \langle \text{cable loss} \rangle + \langle \text{connection loss} \rangle + \langle \text{splice loss} \rangle + \langle \text{CPR adjustment} \rangle.
      2) Note: A connection is defined as the joint made by two mating fibers terminated with remateable connectors (e.g., ST, SC, etc).
   c. 50/125µm Multimode Insertion Loss Coefficients

   1) Cable Loss = Cable Length (km) \times (3.0 \text{ dB/km @ 850-nm or 1.0B/km @ 1300-nm}).
   2) Connection Loss (ST or SC Connectors) = (Connections \times 0.4 \text{ dB}) + 0.42 dB.
   3) Connection Loss (Other mini-connectors) = (Connections \times 0.2 \text{ dB}) + 0.24 dB
   4) Splice Loss = Splices \times (0.05 \text{ dB for fusion or 0.10 dB for mechanical}).
5) CPR Adjustment = See following table:

<table>
<thead>
<tr>
<th></th>
<th>Cat-1</th>
<th>Cat-2</th>
<th>Cat-3</th>
<th>Cat-4</th>
<th>Cat-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Links with ST or SC Connectors</td>
<td>+0.50</td>
<td>0.00</td>
<td>-0.25</td>
<td>-0.50</td>
<td>-0.75</td>
</tr>
<tr>
<td>Links with mini-connectors</td>
<td>+0.25</td>
<td>0.00</td>
<td>-0.10</td>
<td>-0.20</td>
<td>-0.30</td>
</tr>
</tbody>
</table>

d. Singlemode Insertion Loss Coefficients

1) Cable Loss = Cable Length (km) x (0.50 dB/km @ 1310-nm or 0.50 dB/km @ 1550-nm)
2) Connection Loss (ST or SC Connectors) = (Connections x 0.44 dB) + 0.42 dB
3) Connection Loss (Other mini-connectors) = (Connections x 0.24 dB) + 0.24 dB
4) Splice Loss = Splices x (0.07 dB for fusion or 0.15 dB for mechanical)
5) CPR Adjustment = Not applicable for singlemode.

F. Record Documents:

1. All cable and fiber IDs of the test reports shall match the IDs as labeled in the field – i.e., the ID on the cable label/fiber port label shall be the same as what is entered into the stored test result in the power meter.
2. Measurements shall carry a precision through one significant decimal place (minimum).
3. Each test report shall contain the following information (not necessarily in this order):
   a. Project name and address,
   b. General Contractor name / Telecommunications Installer name.
   c. Operator’s name(s),
   d. Date of measurement,
   e. Test equipment - manufacturer, model, and serial number,
   f. Cable identifier, fiber and fiber type,
   g. Measurement direction,
   h. Wavelength, and
   i. Measured loss values.

3.6 BACKBONE TWISTED PAIR CABLELING TESTING REQUIREMENTS AND PROCEDURES

A. Testing Requirements

1. Test backbone multipair cabling per “Base Bid Requirements” in Part 1 of this Section.
2. The installation will be accepted when testing has indicated a 100% availability of all terminated pairs or the Owner has approved any deviation from this requirement.

B. Testing Procedures

1. Test wire map and continuity for all pairs.
2. Test length for 2% of pairs of each cable. None of the pairs tested for length shall be of the same 25-pair binder group.
C. Record Documents

1. All cable and pair IDs of the test reports shall match the IDs as labeled in the field – i.e., the ID on the cable label/termination label shall be the same as what appears on the test reports.
2. Measurements shall carry a precision through no significant decimal place.
3. Each test report shall contain the following information (not necessarily in this order):
   a. Project name and address,
   b. General Contractor name / Telecommunications Installer name,
   c. Operator’s name(s),
   d. Date of measurement,
   e. Test equipment - manufacturer, model, and serial number,
   f. Cable identifier and pair numbers,
   g. Overall test result, and
   h. Measured values of minimum requirements.

3.7 HORIZONTAL CATEGORY 6 TESTING PROCEDURES

A. Precautions

1. Adhere to the equipment manufacturer’s instructions during all testing.
2. Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature – approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for about 15 minutes or for however long it takes to bring the test equipment to reach room temp).
3. Fully charge power sources before each day’s testing activity

B. Test Equipment Set Up

1. Set up the tester to perform a full Category 6 test, as a Permanent Link configuration.
2. If the tester has the capability, set the cable type as product specific setting. If not, set as generic Category 6.
3. Set the tester to save the full test results (all test points, graphs, etc.).
4. Save the test results with the associated cable link identifier to match that as specified in Section 27 15 00.
5. Calibrate the test set per the manufacturers instructions.

C. Acceptable Test Result Measurements

1. Links which report a Fail, Fail* or Pass* for any of the individual tests shall result in an overall link Fail. All individual test results must result in a Pass to achieve an overall Pass.
2. Any reconfiguration of link components required as a result of a test Fail, must be retested for conformance.
3. Any cabling links failing to meet the criteria described in this specification shall be removed and replaced, at no cost to the Owner, with cables that prove, in testing, to meet the minimum requirements.
### Minimum measurement requirements

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Map</td>
<td>All pairs of the cabling link shall be continuous and terminated correctly at both ends. No exceptions shall be accepted.</td>
</tr>
<tr>
<td>Length</td>
<td>The maximum acceptable electrical length measurements for any cabling link measured under a Permanent Link configuration shall be 94 meters, including test cords.</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>The acceptable insertion loss measurements for any Category 6 cabling link shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.</td>
</tr>
<tr>
<td>Worst Pair-to-Pair Near End Cross-Talk (NEXT) Loss</td>
<td>The acceptable worst pair-to-pair NEXT loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.</td>
</tr>
<tr>
<td>Power Sum NEXT Loss</td>
<td>The acceptable power sum PS-NEXT loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.</td>
</tr>
<tr>
<td>Worst Pair-to-Pair ELFEXT and FEXT Loss</td>
<td>The acceptable worst pair-to-pair ELFEXT and loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.</td>
</tr>
<tr>
<td>Power Sum ELFEXT and FEXT Loss</td>
<td>The acceptable PS-ELFEXT and loss for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.</td>
</tr>
<tr>
<td>Return Loss</td>
<td>The acceptable return loss measurements for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.</td>
</tr>
<tr>
<td>Propagation Delay and Delay Skew</td>
<td>The acceptable propagation delay and delay skew measurements for any Category 6 cable shall be no greater than that as listed in TIA/EIA-568B.2 Addendum 1.</td>
</tr>
</tbody>
</table>

### D. Record Documents

1. For each Horizontal Category 6 test measurement, record the following information:
   
   a. Project name and address,
   b. General Contractor name / Telecommunications Installer name,
   c. Operator’s name(s),
   d. Date of measurement,
   e. Ambient temperature,
   f. Test equipment - manufacturer, model, and serial number,
   g. Cable identifier,
   h. Overall test result, and
   i. Measured values of minimum requirements.

END OF SECTION 27 0800
SECTION 27 1100 - COMMUNICATION EQUIPMENT ROOM FITTINGS AND GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.
   B. Requirements of the following Division 27 Sections apply to this section:
      1. Division 27 Section 27 0100 “Basic Communication System Requirements”.
      2. Division 27 Section 27 0500 “Common Work Results for Communications”.

1.2 SUMMARY
   A. This section includes the following:
      1. Racks
      2. Cabinets
   B. This Section includes solid grounding of communications systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.
   C. The Electrical Contractor shall be responsible for grounding equipment provided in the Electrical Contract, HVAC Contract, Plumbing Contract, and General Contract.
   D. The Communication Contractor shall be responsible for proper grounding of all racks, cabinets, and active components as shown on the Drawings and as specified herein.

1.3 SUBMITTALS
   A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
   B. Product data for connectors and connection materials, and grounding fittings.
   C. Field-testing organization certificate, signed by the Contractor, certifying that the organization performing field tests complies with the requirements specified in Quality Assurance below.
   D. Report of field tests and observations certified by the testing organization.
1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with communications grounding work similar to that required for project.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.

1. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. Field-Testing Organization Qualifications: To qualify for acceptance, the independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code" (NEC).

F. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to grounding and bonding.

G. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to grounding.

1.5 DESCRIPTION OF WORK

A. The Communications Contractor shall furnish and supply all equipment, including but not limited to, equipment racks, cabinets, mounting hardware, and all associated equipment necessary to provide a complete and operating system.

B. All bids shall be based on equipment as specified herein. All alternate equipment must be approved ten (10) days prior to bid date. Adequate information must be made available for a evaluation and approval of alternate equipment.

C. Contractor shall furnish a manufacturer's manual of the completed system including individual specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper maintenance and operation of the system must be included. Any bidder using other than the specified equipment must provide this information prior to bidding. All published specifications of the manufacturers of equipment specified shall be considered as being a part of this specification, even though they have not been included in detail.
D. As-built drawings that include any changes to wiring, wiring designations, junction box labeling and any other pertinent information shall be supplied upon completion of project. Refer to Section 27 01 00 for additional requirements.

E. Wire management shall be in accordance with the recommended practices as established by BISCI.

F. All equipment installation and wiring shall meet all requirements of manufacturer.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. B-Line Systems Inc.
2. Burndy Corporation
3. Crouse-Hinds Company
4. Electrical Components Division; Gould Inc.
5. General Electric Supply Company
6. Ideal Industries, Inc.
7. Thomas and Betts Corporation

B. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

C. Conductor Materials: Copper with 98% conductivity.

2.2 WIRE AND CABLE CONDUCTORS

A. General: Comply with Division 26 Section "Low Voltage Electrical Power Cables."

B. Equipment Grounding Conductor: Green insulated.

C. Grounding Electrode Conductor: Stranded cable.

D. Bare Copper Conductors: Conform to the following:


E. Tinned Conductors: ASTM B-33.

2.3 MISCELLANEOUS CONDUCTORS

A. Ground Bus: Bare annealed copper bars of rectangular cross section.
B. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.

C. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

D. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gage bare copper wire; 3/4" wide, 9-1/2" long; 48,250 cm. Protect braid with copper bolt hole ends with holes sized for 3/8" diameter bolts.

2.4 CONNECTOR PRODUCTS

A. General: Listed and labeled as grounding connectors for the materials used.

B. Pressure Connectors: High-conductivity-plated units.

C. Bolted Clamps: Heavy-duty units listed for the application.

2.5 GROUNDING ELECTRODES

A. Signal and Communications: For communication systems, provide a #6 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each rack, cabinet or central equipment location.

B. Bonding Plates, Connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal, and clamp manufacturers for indicated applications.

C. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

2.6 COMMUNICATION ROOM EQUIPMENT

A. Provide the following equipment, including but not limited to, the purchase, delivery, unpacking, installation, connection, testing, and operation of the same.

B. The quantities of items required shall be as shown on the drawings, or as stated below. Where a conflict exists between the quantities shown on the drawings, and the quantities stated hereinafter, the greater of the two quantities shall be used. All Item Tags listed below are referenced to the Item Tags shown and listed on Drawing T310.

C. 19” Floor Rack - Item Tag A01:

1. Description: 19” 4 post server rack
2. Manufacturer/Model No.: Cooper B-Line SB8301908424FB or approved equal.
3. Requirements:
   a. Unit shall be standard 19” width by 84” high 24” depth
b. Unit shall be painted black

4. Accessories:
   a. Hardware
      1) Provide vertical cable management racks on both side of rack, full height.
      2) Provide one horizontal cable management for each 24-port patch panel and two horizontal cable management for each 48-port patch panel installed on the rack, Cooper B-Line SB8701952FB or approved equivalent.
      3) Provide one stationary shelf per IDF Closet, SB745V1919AFB or approved equivalent.
      4) Provide two rack mounted, 10 position power strips per rack not containing patch panels (one rack in each IDF), 10 position power strip, Cooper B-line No. SB300051020LFB or approved equivalent.
   b. Software
      1) None required

5. Quantity: as shown on the Drawings.
6. Remarks: provide engraved label at top center of rack indicating rack number.

D. 19” Wall Rack - Item Tag A02:
   1. Description: 19” distribution rack
   2. Manufacturer/Model No.: CPI/CUBE-IT Plus 36” cabinet # 11900-736 or approved equal.
   3. Requirements:
      a. Unit shall be standard 19” width by 36” high
      b. Unit shall be painted black

4. Accessories:
   a. Hardware
      1) Provide extra mounting rail pair # 12787-536.
      2) Provide fan Kit, 115VAC, 100 CFM # 12804-701.
      3) Provide vertical cable management racks on both side of rack, full height.
      4) Provide one horizontal cable management for each 24-port patch panel and two horizontal cable management for each 48-port patch panel installed on the rack, Cooper B-Line SB719191 or approved equivalent.
      5) Provide one rack mounted, 10 position power strips per wall rack, Cooper B-line No. SB30051020LFB or approved equivalent.
   b. Software
      1) None required

5. Quantity: as shown on the Drawings.
6. Remarks: provide engraved label at top center of rack indicating rack number.

E. Electrostatic Discharge Kit - Item Tag A03:

1. Description: One-hole barrel lug, angled at 45-degrees, permanently marked with protective earth (ground) symbol, designated to accommodate a 4mm ESD wrist strap plug. Kit shall include an antioxidant compound, and one #12-24x ½” threaded-forming screw.
2. Manufacturer/Model No.: Panduit Corporation, part no. RGESD-1 approved equal.
3. Requirements:
   a. Provide one kit for each floor rack or wall cabinet.

4. Accessories:
   a. Hardware
      1) Accessories for a complete and neat installation.
   b. Software
      1) None required.

5. Quantity: one (1) per rack and freestanding cabinet.
6. Remarks: none

F. Ladder Rack - Item Tag A04:

1. Description: 12” wide ladder rack.
2. Manufacturer/Model No.: B-Line, SB17T12B or approved equal.
3. Requirements:
   a. Provide ladder rack extending from cable tray to each equipment rack or wall cabinet.
   b. Provide ladder rack extending from cable tray to each free standing rack.
   c. Ladder Rack shall have 9” rung spacing. Secure ladder rack to rack and cable tray.
   d. Ladder rack shall be painted black.

4. Accessories:
   a. Hardware
      1) Provide mounting and wire management accessories for a complete and neat installation.
   b. Software
      1) None required.

5. Quantity: one (1) per rack and freestanding cabinet.
6. Remarks: none
PART 3 - EXECUTION

3.1 GENERAL

A. Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

3.2 INSPECTION

A. Installer must examine areas and conditions under which grounding connections are to be made and notify the Architect in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

3.3 APPLICATION

A. Provide grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

3.4 INSTALLATION

A. General: Ground communications systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.

B. Coordinate with other electrical work as necessary to interface installation of communication system grounding system with other work.

C. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

3.5 CONNECTIONS

A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.

2. Make connections with clean bare metal at points of contact.

3. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
B. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

A. Upon Completion of installation of communications grounding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 3 ohms, take appropriate action to reduce resistance to 3 ohms, or less, by driving additional ground rods and/or by chemically treating soil encircling ground rod; then retest to demonstrate compliance.

B. Independent Testing Organization: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below.

C. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground resistance level is specified, at service disconnect enclosure ground terminal.

D. Ground/resistance maximum values shall be as follows:

1. Equipment rated 500 kVA and less: 10 Ohms

E. Deficiencies: Where ground resistances exceed specified values, and if directed, modify the grounding system to reduce resistance values. Where measures are directed that exceed those indicated the provisions of the Contract, covering changes will apply.

F. Report: Prepare test reports, certified by the testing organization, of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.7 COMMUNICATION ROOM EQUIPMENT TESTING

A. Before final acceptance of the installation, the contractor shall test in the presence of the Architect/Engineer/Owner or their representative's the complete installation and show that the system is completely operational and free from unwanted grounds, shorts, breaks, etc. The Contractor shall obtain all equipment required to test the final installation. The testing of the system shall be made under the direct supervision of the equipment manufacturer's or their designated representative.

B. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Architect/Engineer/Owner.

END OF SECTION 27 1100
SECTION 27 1300 - COMMUNICATIONS BACKBONE CABLEING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

C. Requirements of the following Division 27 Sections apply to this section:
   1. Division 27 Section 27 0100 “Basic Communication Systems Requirements”.
   2. Division 27 Section 27 0500 “Common Work Results for Communications”

1.2 SUMMARY

A. Section Includes:
   1. Backbone Cabling Description
   2. Products

B. Installation of Cables

1.3 REFERENCE STANDARDS

A. Materials and work specified herein shall comply with the applicable requirements of:
   1. ANSI/TIA/EIA - 568-B Commercial Building Telecommunications Cabling Standard
   2. ANSI/TIA/EIA - 569-A Commercial Building Standard for Telecommunications Pathway and Spaces
   3. EIA/TIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
   4. EIA/TIA-607 Commercial Building Grounding and Bonding requirements for Telecommunications
   5. NFPA 70 - 2002, including:
      a. NEC - Article 770
      b. NEC - Article 800
   6. Underwriters Laboratory
   7. NEMA - 250
   10. BICSI Customer Owned Outside Plant Design Manual (2nd edition)
13. ISO/IEC 11801
14. Bellcore GR-20

1.4 SCOPE OF WORK

A. Add T-drawing numbers for Communication Design drawings
B. Add scope of project.

1.5 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, telecommunication rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities.

C. Bridged taps and splitters shall not be used as part of backbone cabling.

D. Color designations for type fiber cable:
   1. Single Mode fiber > Yellow
   2. Multi Mode fiber 62.5 micron > Orange
   3. Multi Mode fiber 50 micron 1GB > Orange
   4. Multi Mode fiber 50 micron 10GB > Aqua

E. Color and cable type designations for UTP and F/UTP cable:
   1. Voice Riser: UTP CAT3 (minimum) > White

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 MANUFACTURERS

A. Current approved manufacturer. Siemon, Berk-Tek, General Cable, Mohawk, Superior Essex
2.3 SUBMITTALS

A. See Division 1.

2.4 UTP CABLE

A. 24 AWG CAT 3 (or higher rated) plenum riser cable (minimum of 25 pair). Substituted if required by local fire codes.

1. Manufacturers: Siemon, Berk-Tek, General Cable, Mohawk, Superior Essex (Allies for cable only, not for other hardware)

A. Transmission Characteristics:

1. The resistance of any conductor, measured in accordance with ASTM D 4566 shall not exceed 9.38 ohms per 100m at 20 degrees C.
2. The resistance unbalance between the two conductors of any pair shall not exceed 5%.
3. The mutual capacitance of any pair shall not exceed 6.6 nF per 100m.
4. The capacitance unbalance to ground at 1 kHz of any pair shall not exceed 330 pF per 100m.
5. The characteristic impedance shall be 100 ohm +/- 15% from 1 kHz to 16 MHz.
6. The attenuation shall meet the requirements of the horizontal cable specified in section 271500.
7. The insulation between each conductor and the core shield shall be capable of withstanding a minimum dc potential of 5 kV for 3 seconds.
8. The propagation delay of any pair at 10 MHz should not exceed 5.7 ns/m.
9. The Power Sum NEXT loss shall meet the following:
10. Frequency (MHz) NEXT loss (dB)
    a. 0.150 53
    b. 0.772 43
    c. 1.0 41
    d. 4.0 32
    e. 8.0 27
    f. 10.0 26
    g. 16.023

2.5 UTP CABLE HARDWARE

A. Riser cable shall be terminated on Cat3 or higher rated patch panels. Horizontal wire management shall be mounted horizontally between patch panels.

B. Cables will be terminated in numerical order starting with the smallest number.

C. Manufacturer: Siemon, Berk-Tek, General Cable, and Mohawk.
2.6 OPTICAL FIBER CABLE (ISP)
   A. The optical fiber shall be 12 strands OM3 Multi Mode 50/125um core/cladding diameter and 12 strands Single Mode 8.3/125um core/cladding diameter.
      1. Manufacturer: Siemon, BerkTek, General Cable and Mohawk.
   B. The optical fiber cable must be Optical Fiber Conductive Plenum rated or as required.
   C. The fiber optic cable specified in this project may be used to support an ATM or Gigabit Ethernet network. At the time of installation all fiber optic products shall support the latest draft or formal specification released by the IEEE 802.Z (for Gigabit Ethernet).
   D. Non-Conductive cable shall be aluminum-armored type.

2.7 OPTICAL FIBER CABLE HARDWARE
   A. Optical fiber connectors shall be "fusion-spliced pigtails" with LC connector.
   B. Interconnect Units for Telecommunication Rooms shall be 2U rack mounted fiber patch panels, equipped with double density, LC Duplex compatible optical fiber adapter strips (coupler panels).
   C. Interconnect Units for the Equipment Rooms shall be 3U Shelf, equipped with LC duplex Connector Modules.

2.8 OPTICAL FIBER CABLE (OSP)
   A. Multimode Fiber:
      1. Shall be graded-index optical fiber waveguide with nominal 50/125um-core/cladding diameter. The primary coating diameter of 900um UV cured acrylate buffer material.
      2. The fiber shall comply with ANSI/EIA/TIA492AAAA
      3. Transmission Characteristics for Multimode Fiber Optic Cable:
      4. Each cabled fiber shall meet the graded performance specifications below. Attenuation shall be measured in accordance with ANSI/EIA/TIA-455-46, 53 or 61. Information transmission capacity shall be measured in accordance with ANSI/EIA/TIA-455-51 or 30. The measurements shall be performed at 23 degrees C +/- 5 degrees.
         a. Maximum attenuation dB/Km @ 850/1300 nm: 3.25/1.0
         b. Bandwidth 200 Mhz-km @ 850nm
         c. Bandwidth 500 Mhz-km @ 1300nm
   B. Single Mode:
      1. Class IVa dispersion - unshifted single mode optical fibers complying with ANSI/EIA/TIA-492BAAA. Primary coating diameter of 250um UV cured acrylate buffer material.
2. The zero dispersion wavelength shall be between 1300 nm and 1324 nm. The ANSI/EIA/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.093 ps/km-nm². Dispersion measurements shall be made in accordance with ANSI/EIA/TIA-455-169 or ANSI/EIA/TIA-455-175.

3. The nominal mode field diameter shall be 8.7 um to 10.0 um with a tolerance of +/- 0.5 um at 1300 nm when measured in accordance with ANSI/EIA/TIA-455-164 or ANSI/EIA/TIA-455-167.

4. Transmission Characteristics:
   a. Maximum attenuation dB/Km @ 1310/1550 nm: 1.0/1.0
   b. The cutoff wavelength shall <1279 nm when measured in accordance with ANSI/EIA/TIA-455-170
   c. Distance vs. bandwidth using a Laser transmitter operating at a 1310 nm wavelength:

C. Physical Characteristics:
   1. OFNR/OFN Flame Rated meeting U.L. 1666.
   2. Shall be gel-filled.
   3. Strength members shall be FGE/Aramid yarn with extruded PVC sub-cable jacket.
   4. Secondary thermoplastic type buffer over each fiber.
   5. Suitable for underground or aboveground conduits.
   6. Shall have individual fiber tube colors per TIA/EIA-606 and overall orange or black jacket.
   7. Provide stiff central member with cables stranded around center.
   8. Provide ripcord for overall jacket.
   9. Suitable for -40o to +75o C.
   10. Suitable for lashing.
   11. Must be UV rated when used for exterior/areial installation.

PART 3 - EXECUTION

3.1 GENERAL
   A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
   B. All installation shall be in accordance with manufacturer’s published recommendations.
   C. Copper cables shall be terminated with connecting hardware of same category or higher.
   D. Install plenum cable in environmental air spaces, including plenum ceilings.

3.2 INSTALLATION OF CABLES
   A. General Requirements for Cabling:
1. Terminate all conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

2. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

3. Install lacing bars to restrain cables consistently, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii.

5. Use Velcro tie wraps.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

7. Cold-Weather Installation: Follow manufacturer specifications for installation and storage temperatures. Heat lamps shall not be used for heating.

8. In the communications equipment room, install a 10-foot service loop for backbone cabling on each end of cable.

9. Pulling Cable: Do not exceed manufacturer recommended maximum cable pull tensions.

B. UTP Cable Installation:

1. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

C. Optical Fiber Cable Installation:

1. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

2. The metal armor of the optical fiber cable must be grounded.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend UTP cable independently from “Other Trades” and not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.

3. Cable shall not be run through or supported from structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

END OF SECTION 27 1300
SECTION 27 1500 - COPPER CABLING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to this section.

B. Requirements of the following Division 27 Sections apply to this section:

1. Division 27 Section 27 0100 “Basic Communication System Requirements”.
2. Division 27 Section 27 0500 “Common Work Results for Communications”.

1.2 SUMMARY

A. This Section includes copper cables and jacks designed and used for voice/data networks.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Submittals shall be made as complete systems including all required accessories and special installation tools (i.e. termination hardware).

C. Product information including the following cable transmission characteristics:

1. Insertion Loss
2. Near-end Crosstalk (NEXT)
3. Power Sum Near-end Crosstalk (PS NEXT)
4. Attention-to-Cross Talk Ratio (ACR)
5. Power Sum Attention-to-Cross Talk Ratio (PS ACR)
6. ELFEXT
7. Power Sum ELFEXT (PS ELFEXT)
8. Return Loss
9. Skew
10. LCL

D. Manufacturers complete installation instructions including, but not limited to, the following information:

1. Minimum bend radius
2. Maximum pulling tension
3. Recommended installation of pulling points (i.e. every 270 degrees of bends in the conduit, or every 150 feet of raceway)
E. Provide information regarding all terminations that will be required to complete this installation. This information shall include complete specifications and installation instructions.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."

B. Toxicity: Comply with applicable codes and regulations regarding toxicity of combustion products of materials used in voice/data cables.

C. UL Compliance: Comply with applicable requirements of UL Standard 910 "Test Method for Fire and Smoke Characteristics of Cables Used in Air Handling Spaces." Provide products that are UL-listed and labeled for such use.

D. Comply with the following Electronic Industries Association (EIA) and Telecommunications Industry Association (TIA) Standards:

1. TIA/EIA-568-B, "Commercial Building Telecommunications Wiring Standard"
2. TIA/EIA-569-A, "Commercial Building Standard for Telecommunications: Pathways and Spaces"
3. TIA/EIA-570, "Residential and Light Commercial Telecommunications Wiring Standard"
4. TIA/EIA-606-A, "The Administration Standard of the Telecommunications Infrastructure of Commercial Building"
5. EIA Standards EIA-230, "Color Marking of Thermoplastic Wire" and
6. EIA-258, "Semi-Flexible Air Dielectric Coaxial Cables and Connectors, 50 Ohms."

E. MIL-SPEC Compliance: Comply with " MIL-C-55021, "Twisted-Pair and Triplet Cables;"

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver cable factory-packaged in containers or reels. Store in clean dry space and protect products from damaging fumes and traffic. Handle wire and cable carefully to avoid damage.

PART 2 - PRODUCTS

2.1 UNSHIELDED TWISTED PAIR (UTP) VOICE/DATA CABLE AND JACKS

A. General: Provide unshielded twisted pair cable of manufacturer's standard materials as indicated on the drawings. All cables shall be designed and constructed as recommended by the system/equipment manufacturer, for a complete installation and for applications indicated.

B. Manufacturers: All cable and connectors for the voice/data system shall be provided in compliance with the warranty requirements of section 27 01 00.
C. Manufacturers: Subject to compliance with requirements, provide unshielded twisted-pair cabling products and connectivity products of one of the following:

1. Connectivity/Cable:
   a. Panduit connectivity with General Cable.
   b. ADC/Krone.
   c. Hubbell Premise Wiring, Hubbell Incorporated connectivity with General Cable Corporation cable, or cable as warranted by Hubbell Premise Wiring.
   d. Ortronics with Berk-Tek cable.
   e. Siemons connectivity with Belden Cable, General Cable, Berk-Tek Cable or Mohawk Cable.
   f. SYSTIMAX SCS connectivity with SYSTIMAX SCS cable.
   g. Tyco Electronics, AMP Netconnect connectivity with Tyco Electronics, AMP Netconnect cabling.
   h. Leviton connectivity with Belden Cable, General Cable, Berk-Tek Cable or Mohawk Cable.

D. Category 3 Voice UTP Cable and Jacks

1. Provide where indicated on the Drawings or where required by the Specifications, standard TIA/EIA Category 3 unshielded twisted pair cable complete with jacks.
2. Provide plenum rated cable in all areas having plenum rated ceiling. All areas of the building shall be considered as having plenum rated ceiling unless noted otherwise on the Drawings.
3. Category 3 UTP cable shall meet the following requirements:
   a. Provide the 50 pair cables as indicated on the drawings.
   b. Manufacturer/Model Number: Provide cable manufactured by one of the following companies:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Series</th>
<th>Plenum (CMP)</th>
<th>Riser (CMR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC/Krone</td>
<td>YXV0024-19xx</td>
<td>D024D0-GYxx</td>
<td></td>
</tr>
<tr>
<td>Belden</td>
<td>12xxA2 series</td>
<td>12xxA1 series</td>
<td></td>
</tr>
<tr>
<td>Berk-Tek</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Cable Corporation</td>
<td>2131 series</td>
<td>2133 series</td>
<td></td>
</tr>
<tr>
<td>SYSTIMAX SCS</td>
<td>2010 series</td>
<td>1010 series</td>
<td></td>
</tr>
<tr>
<td>Tyco Electronics/AMP NetConnect</td>
<td>219567-X</td>
<td>219560-X</td>
<td></td>
</tr>
</tbody>
</table>

4. Provide 110 connector blocks to accommodate 50 pair cabling at the MDF (Technology A115a) room from each Data Closet (IDF) on each floor. Provide Field Termination Kit for 50 pair with 5 pair per block, Panduit P110KB100Y. Equivalent manufacturers shall be ADC/Krone, Hubble, Ortronics, Siemons, Tyco Electronics. Provide all accessories for a complete system of terminations for 50 pair, Cat. 3 telephone cabling.
5. Jacks and Patch Panels:
   a. All jacks shall be RJ-45, 568B configuration.
   b. Patch Panel shall be in 24 or 48-port configuration as required by the number of workstation cables (plus 10%).
   c. Manufacturer/Model Number: Provide jacks manufactured by one of the following companies:

<table>
<thead>
<tr>
<th>Manufacturer/Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC/Krone 6467-1-095-xx</td>
</tr>
<tr>
<td>Hubbell HXJ3 series</td>
</tr>
<tr>
<td>Ortronics</td>
</tr>
<tr>
<td>Siemens MX3 series</td>
</tr>
<tr>
<td>SYSTIMAX SCS M1 series</td>
</tr>
<tr>
<td>Tyco Electronics/AMP 406373-X</td>
</tr>
<tr>
<td>NetConnect Panduit DP6 PLUS Mini-Com</td>
</tr>
<tr>
<td>Leviton eXtreme 6 +</td>
</tr>
</tbody>
</table>

E. Category 6e Voice/Data UTP Cable:
   1. Provide where indicated on the Drawings or where required by the Specifications, enhanced TIA/EIA Category 6e unshielded twisted pair cable.
   2. Provide plenum rated cable in all areas having plenum rated ceiling. All areas of the building shall be considered as having plenum rated ceiling unless noted otherwise on the Drawings.
   3. Cable/connectivity system shall be certified by Graybar Electric Company, Inc., as compliant the VIP 2000 program and/or Anixter Inc., as compliant with the Levels XP7 program.
   4. Category 6e UTP cable shall meet the following requirements:
      a. Structured cabling system shall support 1GB Ethernet.
      b. All cables shall have 4-pairs with a pair separator built into the cable.
      c. All Category 6e cables shall meet the minimum requirements of the TIA/EIA-568B.2-1 Category 6e and ISO 11801 2nd Edition Class E channel standards.
      d. All cables shall be tested by ETL, UL, or an equal third-party testing organization as approved by the Engineer. All cables shall be third-party tested using a standard TIA/EIA 4-connector channel test. Provide printed test reports from the third-party testing organization with the Submittals indicating the following minimum performance requirements:

<table>
<thead>
<tr>
<th>Test</th>
<th>Statistics</th>
<th>Frequency (MHz)</th>
<th>Channel (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACR</td>
<td>Minimum</td>
<td>250</td>
<td>20.2</td>
</tr>
<tr>
<td>ACR</td>
<td>Typical</td>
<td>250</td>
<td>24.7</td>
</tr>
<tr>
<td>PS ACR</td>
<td>Minimum</td>
<td>100</td>
<td>30.9</td>
</tr>
<tr>
<td>PS ACR</td>
<td>Typical</td>
<td>100</td>
<td>33.0</td>
</tr>
<tr>
<td>PS ACR</td>
<td>Minimum</td>
<td>250</td>
<td>17.7</td>
</tr>
<tr>
<td>PS ACR</td>
<td>Typical</td>
<td>250</td>
<td>19.4</td>
</tr>
</tbody>
</table>
1) TIA/EIA standard test
2) minimum means worst-case value, typical means average value
3) test frequency
4) 100 meter channel test results, plenum (CMP) cable
5) 90 meter link test results
6) submit values for Link test

5. Manufacturer/Model Number: Provide cable manufactured by one of the following companies:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Series</th>
<th>Plenum (CMP)</th>
<th>Riser (CMR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC/Krone</td>
<td>TrueNet 6</td>
<td>6TP-xxyy</td>
<td>6TRT-xxyy</td>
</tr>
<tr>
<td>Belden</td>
<td>Media Twist</td>
<td>1874A series</td>
<td>1872A series</td>
</tr>
<tr>
<td>Berk-Tek</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Cable Corporation</td>
<td>GenSpeed TX6500</td>
<td>7131431</td>
<td>7133374</td>
</tr>
<tr>
<td>SYSTIMAX SCS</td>
<td>GigaSPEED XL</td>
<td>2071 series</td>
<td>1071 series</td>
</tr>
<tr>
<td>Tyco NetConnect</td>
<td>Electronics/AMP</td>
<td>219567-X</td>
<td>219560-X</td>
</tr>
</tbody>
</table>

6. Jacks and Patch Panels:
   a. All jacks shall be RJ-45, 568B configuration. Provide dark orange color jack for data connections and provide dark green color jack for telephone connections. Exact location of all telephones shall be coordinated with Owner prior to termination of jack.
   b. Patch Panel shall be in 24 or 48-port configuration as required by the number of workstation cables.
   c. Manufacturer/Model Number: Provide jacks and patch panels manufactured by one of the following companies:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Series</th>
<th>Jacks</th>
<th>Patch Panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC/Krone</td>
<td>TrueNet 6</td>
<td>EC06-xx</td>
<td>EC06-PANELxx</td>
</tr>
<tr>
<td>Hubbell</td>
<td>HXJ6 series</td>
<td>P6xxUE series</td>
<td></td>
</tr>
<tr>
<td>Ortronics</td>
<td>System 6</td>
<td>MX6 series</td>
<td>HD6 series</td>
</tr>
<tr>
<td>Siemens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYSTIMAX SCS</td>
<td>MGS-400 series</td>
<td>1100GS3 series</td>
<td></td>
</tr>
<tr>
<td>Tyco NetConnect</td>
<td>Electronics/AMP</td>
<td>1375055-X</td>
<td>137501X-1</td>
</tr>
<tr>
<td>Panduit</td>
<td>DP6 PLUS</td>
<td>Mini-Com</td>
<td>DP6 Plus UTP</td>
</tr>
<tr>
<td>Leviton</td>
<td>eXtreme +</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PART 3 - EXECUTION

3.1 INSTALLATION OF VOICE/DATA CABLES

A. Voice/data cables shall be installed with a minimum 18" clearance from light fixtures, electrically operated equipment and all wiring operating at 120 or more volts.

B. Voice/data cables shall be installed in accordance with manufacturer's written instructions and in compliance with NEC.

C. Coordinate installation with other Work.

D. Install without damaging conductors or jacket.

E. Do not, either in handling or installation, bend cable to smaller radii than minimum recommended by manufacturer.

F. Ensure that minimum manufacturer's recommended pulling tensions are not exceeded.

G. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway.

H. Install all cable parallel and/or perpendicular to building surfaces or exposed structural members, and follow surface contours where possible. In ceiling cavities, install cables at bottom of trusses.

I. Provide “J” hooks for all cables not installed in raceways. “J” hooks shall be spaced no greater than five feet (60") on center, with a maximum spacing of four feet (48") for bundles of 20 or more cables. Do not exceed manufacturer’s capacity for “J” hooks.

J. No cable splices are allowed.

3.2 TERMINATIONS

A. Terminations at the RJ-45 voice/data jacks shall be made in accordance with TIA/EIA Standard T568B.

3.3 COLOR CODING

A. The color of the outer jacket of all patch cables within closets shall be the same, and shall as follows:

<table>
<thead>
<tr>
<th></th>
<th>Plenum</th>
<th>Non-Plenum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber Optic</td>
<td>orange</td>
<td>orange</td>
</tr>
<tr>
<td>Category 5 or 6</td>
<td>dark orange</td>
<td>dark orange</td>
</tr>
<tr>
<td>Surveillance(#)</td>
<td>yellow</td>
<td>yellow</td>
</tr>
<tr>
<td>Fire alarm(9)</td>
<td>red</td>
<td>red</td>
</tr>
<tr>
<td>AMX System/Intercom(*)</td>
<td>gray</td>
<td>gray</td>
</tr>
</tbody>
</table>
Security: beige beige
Telephone: dark green dark green
Wireless access points: blue blue
Massage System Display: black black

(*) Part of Division 27 Contract
(#) Part of Division 28 Contract

B. All voice/data wiring strands shall be color coded as follows:

<table>
<thead>
<tr>
<th>Pair</th>
<th>Tip</th>
<th>Ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>White/Blue</td>
<td>Blue</td>
</tr>
<tr>
<td>#2</td>
<td>White/Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>#3</td>
<td>White/Green</td>
<td>Green</td>
</tr>
<tr>
<td>#4</td>
<td>White/Brown</td>
<td>Brown</td>
</tr>
</tbody>
</table>

C. This color-coding shall be consistent and continuous throughout the system.

3.4 TRAINING

A. Provide adequate length of conductors within boxes at workstation end. Leave sufficient cable length within box to allow for easy removal of faceplate and devices. At the workstation end, leave 24” of excess cable above finished ceiling, directly above voice/data outlet, coil excess cable in a 10” loop with four tie wraps.

B. Provide adequate length of conductors at patch panels and at punch down blocks. Leave sufficient cable length so that cables can be trained vertically down ladder rack and vertical wire management accessories without cables being tight. All cables shall be secured with Velcro straps every 12” on center on the rack/cabinet and the ladder racks. Tie wraps shall not be acceptable.

3.5 FIELD QUALITY CONTROL

A. Prior to usage, test each cable for electrical continuity, short circuits, length, mapping and pairing, attenuation, return loss, NEXT, PSNEXT, ACR, PSACR, ELFEXT, and PSELFEXT.

B. Test all cable segments for faulty connectors, terminations, and the integrity of the cable and its component parts.

C. System Certification Testing

1. Test the entire cabling system in accordance with the termination manufacturer’s warranty program. Warranty programs are specified in section 27 01 00.

2. Coordinate this testing with the Architect and Engineer. Notify both the Architect and Engineer at least seven days in advance of testing in order for the Architect and Engineer to make plans to witness this testing.

3. After all punchdowns and cable terminations are complete test each cable from the workstation outlet to the patch panel. Perform both channel and link tests.

4. This testing shall be conducted with a LAN Tester, as manufactured by Microtest, Wavetek, or as approved by the cable/termination manufacturer.
5. Measure and record the following data: mapping and pairing, attenuation, return loss, NEXT, PSNEXT, ACR, PSACR, ELFEXT, and PSELFEXT.

6. Document the test results in graphic plot/text format immediately following the testing. Documentation shall be in printed form, 8½” x 11” paper printed via a laser printer. Provide two copies of the recordings bound in two separate cable record books, indexed for easy reference and transmit these books to the Architect for review by the Engineer. Bind the original recordings in a cable record book indexed for easy reference during future maintenance operations and turn book over to the Owner's authorized representative.

3.6 COMMISSIONING

A. Subsequent to installation of voice/data cable and equipment demonstrate proper functioning. Replace malfunctioning components with new materials, and then retest until satisfactory performance is achieved.

END OF SECTION 27 1500
SECTION 27 1510 - STRUCTURED CABLELING SYSTEM COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections include the following:

1. Division 27 Section 27 0100 “Basic Communication System Requirements”.
2. Division 27 Section 27 0500 “Common Work Results for Communication”.
3. Division 27 Section 27 1300 “Fiber Optic Cabling Systems”.
4. Division 27 Section 27 1500 “Copper Cabling Systems”.

1.2 GENERAL

A. This Section includes the following:

1. Individual structured cabling system components.

1.3 DESCRIPTION OF WORK

A. The Communications Contractor shall furnish and supply all equipment, including but not limited to, UTP cabling, fiber optics cable, patch panels, and other equipment necessary to provide a complete and interconnected structured cabling system.

B. Contractor shall furnish a manufacturer's manual of the completed system including individual specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper maintenance and operation of the system must be included. All published specifications of the manufacturers of equipment specified shall be considered as being a part of this specification, even though they have not been included in detail. Any bidder using other than the specified equipment must provide this information prior to bidding.

C. As-built drawings that include any changes to wiring, wiring designations, junction box labeling and any other pertinent information shall be supplied upon completion of project. Refer to Section 27 01 00 for additional requirements.

D. Cabling system shall be in accordance with good engineering practices as established by the BISCI, TIA/EIA, and NEC, and any other applicable codes or regulations.

E. All equipment installation and cabling shall meet all requirements of manufacturer.
PART 2 - PRODUCTS

2.1 REQUIRED EQUIPMENT

A. Provide the following items, including but not limited to, the purchase, delivery, unpacking, installation, connection, testing, and operation of the same.

B. The quantities of items required shall be as shown on the drawings, or as stated below. Where a conflict exists between the quantities shown on the drawings, and the quantities stated hereinafter, the greater of the two quantities shall be used. All Item Tags listed below are referenced to the Item Tags shown and listed on the Riser Diagram on the Drawings.

C. Category 6 Workstation Cable - Item Tag C01:

1. Description: TIA/EIA standard Category 6 horizontal distribution cable.
2. Requirements:
   a. Cable shall meet performance characteristics specified in Section 27 1500 of the Specifications.
   b. Cable shall be plenum rated for all cable routed through the ceiling.
3. Accessories:
   a. None
4. Quantity: as shown and scheduled on the Drawings.
5. Remarks: None

D. Category 6 Patch Panel - Item Tag C02:

1. Description: TIA/EIA standard Category 6 RJ-45 patch panel.
2. Requirements:
   a. Patch panel shall meet performance characteristics specified in Section 27 1500 of the Specifications.
   b. Patch panel shall be rack mounted.
3. Accessories:
   a. Rack mount hardware.
   b. Labeling hardware.
4. Quantity: As shown and scheduled on the drawings
5. Remarks: None

E. Category 6 Cross Connect Cable - Item Tag C03:

1. Description: factory fabricated TIA/EIA standard Category 6 cross connect cable.
2. Requirements:
   a. Cable shall be used to cross connect patch panel to network switch.
   b. Cable shall meet performance characteristics specified in Section 27 1500 of the Specifications.
   c. Cables shall average 7’ in length. Quantities of different lengths will be required for this project. Coordinate actual lengths with Owner prior to ordering.
   d. Cables shall be colored. Coordinate color with Owner prior to ordering.

3. Accessories:
   a. None

4. Quantity: provide one (1) cross connect cable for each port in each workstation patch panel (item C02). Cross-connect cables are required only for the patch panels; cross-connect cables are not required for each workstation (wall or floor) outlet.

5. Remarks: None

F. Category 3 Telephone Cable - Item Tag C04:
1. Description: 50-pair TIA/EIA standard Category 3 telephone cable
2. Requirements:
   a. Cable shall meet performance characteristics specified in Section 27 1500 of the Specifications.
   b. Cable shall be plenum rated.
   c. Cables shall extend from rack mounted RJ45 patch panels in each IDF to wall mounted 110 blocks in Technology A115a.
   d. Terminate all cables on RJ45 patch panels.

3. Accessories:
   a. None

4. Quantity: As shown and scheduled on the drawings.
5. Remarks: None

G. Fiber Optic Distribution Cable - Item Tag C05:
1. Description: 12-strand 50um multi-mode fiber optic cable and 6-strand 50um single-mode fiber optic cable
2. Manufacturer/Model No.: Refer to Section 27 13 00 of the Specifications.
3. Requirements:
   a. Cable shall extend from rack-mounted distribution shelf in IDF to rack mounted distribution shelf in Technology A115a.
   b. Cable shall meet performance characteristics specified in Section 27 1300 of the Specifications.
   c. Cable shall be plenum rated.
   d. All strands of the cable shall be terminated at both ends.
e. Cable shall be suitable for 10 Gigabit Ethernet at 300 meters 50/125um (OM3) multimode plenum rated.

4. Accessories:
   a. None

5. Quantity: as shown on the Drawings.
6. Remarks: None

H. 24-Strand F.O. Distribution Shelf - Item Tag C06:
1. Description: 24-port fiber optic rack mounted distribution shelf
2. Manufacturer/Model No.: Panduit Opticom QuickNet series.
3. Requirements:
   a. Cable shall meet performance characteristics specified in Section 27 1300 of the Specifications.
   b. Cable shall be plenum rated.
4. Accessories:
   a. None
5. Quantity:
6. Remarks: none

I. Wall-Mounted Category 6 Data Jack - Item Tag C07:
1. Description: wall mounted TIA/EIA standard Category 6 data jack(s)
2. Requirements:
   a. Number of jacks per outlet as shown on the drawings.
3. Accessories:
   a. None
4. Quantity: as shown on the Drawings.

J. Surface-Mounted Raceway Category 6 Data Jack - Item Tag C08:
1. Description: TIA/EIA standard Category 6 data jack(s) mounted in surface mounted raceway
2. Requirements:
   a. Number of jacks per outlet as shown on the drawings.
3. Accessories:
   a. None
4. Quantity: as shown on the Drawings.

K. **Floor Box Category 6 Data Jack - Item Tag C09**

1. Description: TIA/EIA standard Category 6 data jack(s) mounted in floor box.
2. Requirements:
   a. Number of jacks per outlet as shown on the drawings.
   b. Install a maximum of 3 data jacks per insert plate.
3. Accessories:
   a. None
4. Quantity: as shown on the Drawings.
5. Remarks: None

L. **Wireless Access Point Category 6 Data JACK/MODULAR PLUG - Item Tag C10:**

1. Description: TIA/EIA standard Category 6 above ceiling MODULAR JACK for wireless access point
2. Manufacturer/Model No.: Panduit TX6 Plus UTP Modular Plug model number SP688-C series.
3. Requirements:
   a. One jack per location as shown on the drawings.
4. Accessories:
   a. None
5. Quantity: as shown on the Drawings.

M. **Surveillance Camera locations: Category 6 Data JACK/MODULAR PLUG - Item Tag C11:**

1. Description: TIA/EIA standard Category 6 above ceiling MODULAR JACK for Network IP Cameras
2. Manufacturer/Model No.: Panduit TX6 Plus UTP Modular Plug model number SP688-C series.
3. Requirements:
   a. Number of jacks per location as shown on the drawings.
4. Accessories:
   a. None
5. Quantity: as shown on the Drawings.
N. Wall-Mounted Category 3 110 Cross Connect Block - Item Tag C12:

1. Description: Wall mounted TIA/EIA Category 5 110 cross connect blocks
2. Requirements:
   a. 110 cross connect blocks shall meet performance characteristics specified in Section 27 15 00 of the Specifications.
   b. 110 cross connect blocks shall be wall mounted.
3. Accessories:
   a. Wall-mount hardware.
   b. Labeling hardware.
4. Quantity: as shown on the Drawings.
5. Remarks: None

PART 3 - EXECUTION

A. Before final acceptance of the installation, the contractor shall test in the presence of the Architect/Engineer/Owner or their representative's the complete installation and show that the system is completely operational and tests to the performance levels of the cable specified. The Contractor shall obtain all equipment required to test the final installation. The testing of the system shall be made under the direct supervision of the equipment manufacturer's or their designated representative.

B. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. In addition, the structured cabling systems shall have a 25-year warranty. Guarantee period shall begin on the date of acceptance by the Architect/Engineer/Owner.

END OF SECTION 27 1510
SECTION 27 2100 - DATA COMMUNICATIONS NETWORK SYSTEMS

PART 1 - GENERAL

1.1 THIS SECTION IDENTIFIES THE DATA COMMUNICATIONS NETWORK SYSTEM DESIGN AND SPECIFICATIONS REQUIREMENTS FOR THE QUAKER VALLEY SCHOOL DISTRICT (“OWNER”).

A. Contractor shall provide all materials, equipment and labor necessary to provide a complete and functional Industry Standard Data Communications Network System regardless of any materials and/or equipment not listed or described in this specification and/or supplementary drawings.

B. Contractor shall verify conditions and dimensions at the job site prior to installation.

C. Contractor shall provide installation in accordance with these written specifications and the installation requirements, recommendations and guidelines of the product’s manufacturer.

D. Contractor shall provide in addition to Division 1 requirements, an itemized listing of all equipment, materials and labor required for the installation of the Data Communications Network System as specified herein. Listing shall contain: Part Number, Description, Unit of Measure and Quantity, to provide a complete and functional Data Communications Network System as specified herein.

E. All new construction will require a complete Data Communications Network System within the Middle School while areas of the existing facilities receive additions and or renovations will require modifications to the existing Data Communications Network System. The Middle School building houses the district core switch Cisco 6509. Bidder shall include labor to install, configure and test all additional Data Network Hardware to support the System.

F. In Addition to the wired network within the Middle School the District requires an 802.11a/b/g/n based on Cisco Aironet 1140 and CleanAir 3500 Access Points.

G. The data network equipment shall be installed and configured in accordance to the District’s direction.

1.2 REQUIREMENTS INCLUDED

A. This Specification, establishes the requirements necessary to achieve the intended performance and function of a Data Network System (DNS)

B. The DNS consists of data delivery and distribution equipment integrated together to form a cohesive integrated communication system.
C. Provide as part of the bid proposal a complete bill of materials, including catalog cuts and equipment configurations.

D. Provide the services necessary to furnish, install, train, and to provide maintenance to support the DNS including an integrated system of peripheral apparatus conforming to acceptable industry standards. All work shall be in accordance with the true intent of the Specifications, and as required to leave the DNS complete and in satisfactory operating condition, excluding those items listed under “Work by Others.”

E. The DNS shall be new, of modern design, and current standard production of the manufacturer.

F. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, Manufacturers recommendations and the latest edition or revision of all applicable codes and standards.

G. The DNS includes providing and integrating the following principal systems:

1. Provide all fiber optic patch cables and components to provide connection between the MCC and the IDF’s rooms for LAN/WAN/WLAN connectivity.
2. Provide wireless LWAPP devices for 40 wireless access data network outlets (WAP) as shown on the contract drawings.
3. Provide data network hardware in the MCC and the IDF’s rooms as specified and shown on the drawings.
4. Provide all necessary system software and configuration for a complete and working system. Contractor shall include labor to tune and modify existing VLANs per QVSD direction.
5. Provide centralized administrative software and hardware to administer the system.
6. Training of the District personal on the administration of the network.

H. Furnish and install a DNS system incorporating the software, Ethernet LAN, wireless devices and appropriate testing equipment to perform testing as hereinafter described.

I. Provide any additional items, not specifically mentioned herein, necessary to meet system requirements as specified, without claim for additional payment.

1.3 RELATED REQUIREMENTS

A. The Drawings, Specifications, General Conditions, Supplementary Conditions and other requirements of Division 1, apply to the work specified in Division 27, and shall be complied with in every aspect. The Contractor shall examine the documents, which make up the Contract Documents and shall coordinate them with the work on the Technology Drawings and Division 27 of these specifications.

B. Please check with engineer before final purchasing of equipment to make sure current parts lists are correct and have not changed since bid award.

C. The contractor will be responsible for the delivery of equipment directly to the site or to the contractor’s staging facility. Under no circumstances, will the District accept any equipment delivered directly to any QVSD location. If such an attempt is made, the District will order the equipment returned to the manufacturer/distributor at the Contractor’s expense.
D. The contractor will be responsible for verification of receipt of equipment and storage at the site as specified by the contract documents.

E. The contractor must provide a project manager who will be responsible for coordination of all activities of contractor’s staff.

F. The contractor must commit adequate manpower to complete the work within the schedule as set by the contract documents.

G. All installation schedules and procedures must be coordinated with and approved by construction manager and engineer.

H. QVSD will provide configuration templates and installation information for all equipment.

I. The contractor will be required to provide QVSD with network documentation and should be able to edit documents in Microsoft Visio, Word and Excel.

J. The contractor shall be responsible for installing and recording QVSD inventory tag and system serial number information and providing this information in final closeout documentation.

K. The newly installed equipment must meet QVSD standards for appearance, neatness, cable dressing, etc.

L. Testing and verification of functionality of the newly installed equipment by the contractor will be required. QVSD will provide testing procedures and checklists to be followed.

M. Disposal of all packing materials will be the responsibility of the contractor.

1.4 CONTRACTOR REQUIREMENTS

A. The Contractor shall be a Cisco Certified Gold partner prior to submitting a proposal for the work.

B. The Contractor shall possess all relevant Manufacturer Certifications for the company and installers prior to submitting a proposal for the work.

C. Installers shall be trained on the specific equipment installation, configuration and testing of systems as specified prior to submitting a proposal for the work.

D. For Alternate Bids listing alternate manufacturers, provide documentation indicating certification with that manufacture.

1.5 CONFLICT BETWEEN DRAWINGS AND SPECIFICATIONS

A. It is intended that any contractor furnishing materials or labor necessary for the completion of this specification shall furnish it in compliance with this specification. Where conflict exists with other specifications concerning such materials and labor, this specification takes precedence unless otherwise approved in writing by the District.
B. Drawings pertaining to this specification shall be considered as a part of said specification and shall be a part of the bid documents.

1.6 RELATED WORK PROVIDED BY OTHERS

A. The file servers, associated operating software and application software for the LAN will be provided under separate contract.

B. The personal computers located in the offices and classrooms will be purchased under separate contract complete with NIC cards.

C. The printers located in the offices and classrooms will be provided under separate contract.

D. Data cabling infrastructure will be provided under section 27 1500.

E. Data cabinets and racks will be furnished and installed under section 27 1100.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. The following sections specifically list the acceptable equipment types and items for this project. Proposed equivalent items must meet or exceed these specifications and the specifications of the listed item. In the event a specified manufacturer’s part number has changed or is no longer valid, Contractor shall substitute the appropriate equivalent manufacturer’s part number. Owner or Owner’s designate will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to installation. Where quantities are not noted, they may be obtained from the drawings. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished. Any Owner-furnished materials or equipment not installed in the project shall be returned to the Owner. Contractor shall store all materials and equipment in accordance with manufacturers' instructions in a weathertight, secure enclosure. Contractor shall be responsible for safety and security of all Owner-furnished materials until project is complete and accepted by Owner.

B. All equipment and materials, unless otherwise specified, shall be new, free from any defects, and of the best quality of their respective kinds. All like materials used shall be of the same manufacture, model, and quality, unless otherwise specified.

C. Manufacturer's names are listed herein to establish a standard.

D. To provide compatibility with the existing network hardware, all data networking equipment shall be Cisco or approved equal.
2.2 LAN COMPONENTS:

A. Core Switch 6509 Components (Room A115a)
   1. Provide sixteen (16) 1000BASE-T SFP GLC-T
   2. Provide fifteen (15) GLC-SX-MM

B. Edge Ethernet Switches (MDF) - Catalyst 3750 (Room A115a)
   1. Provide two (2) Catalyst 3750X 48 Port PoE IP Base (WS-C3750X-48PF-S)
   2. Provide two (2) Catalyst 3750X 48 Port IP Base (WS-C3750X-48T-S)
   3. Provide one (1) Cisco StackWise 1M Stacking Cable (CAB-STACK-1M)
   4. Provide one (1) Cisco Stack Power Cable 150 CM.
   5. Cisco StackWise 50Cm Stacking Cable (CAB-STACK-50CM) included
   6. Provide two (2) GbE port (3KX-NM-1GLC-SX)
   7. Provide two (2) SFP GL-SX-MM

C. Edge Ethernet Switches (IDF) - Catalyst 3750G (Room B121)
   1. The Owner shall furnish (15) fifteen existing Cisco WS-C3750G-24PS switches to this contractor for installation in racks within this room. Switches shall be removed by the Owner prior to demolition commencing in building and shall be stored off-site by the Owner until the building is ready for reinstallation of switches by this contractor. Owner shall furnish all stack cables to this contractor for connecting switches.
   2. Provide two (2) Cisco StackWise 1M Stacking Cable (CAB-STACK-1M)

D. Edge Ethernet Switches (IDF) - Catalyst 3750 (Room B217)
   1. Provide two (2) Catalyst 3750X 48 Port PoE IP Base (WS-C3750X-48PF-S)
   2. Provide five (5) Catalyst 3750X 48 Port IP Base (WS-C3750X-48T-S)
   3. Provide one (1) Cisco Stack Power Cable 150 CM
   4. Provide one (1) Cisco StackWise 3M Stacking Cable (CAB-STACK-3M)
   5. Cisco StackWise 50Cm Stacking Cable (CAB-STACK-50CM) included
   6. Provide two (2) GbE port (3KX-NM-1GLC-SX)
   7. Provide four (4) SFP GL-SX-MM

E. Edge Ethernet Switches (IDF) - Catalyst 3750 (Room B319)
   1. Provide two (2) Catalyst 3750X 48 Port PoE IP Base (WS-C3750X-48PF-S)
   2. Provide three (3) Catalyst 3750X 48 Port IP Base (WS-C3750X-48T-S)
   3. Provide one (1) Cisco Stack Power Cable 150 CM
   4. Provide one (1) Cisco StackWise 3M Stacking Cable (CAB-STACK-3M)
   5. Cisco StackWise 50Cm Stacking Cable (CAB-STACK-50CM) included
   6. Provide two (2) GbE port (3KX-NM-1GLC-SX)
   7. Provide four (4) SFP GL-SX-MM

F. Edge Ethernet Switches (IDF) - Catalyst 3750 (Room C309b)
   1. Provide one (1) Catalyst 3750X 48 Port PoE IP Base (WS-C3750X-48PF-S)
   2. Provide one (1) GbE port (3KX-NM-1GLC-SX)
   3. Provide one (1) SFP GL-SX-MM
G. Spares

1. Provide one (1) Catalyst 3750X 48 Port PoE IP Base (WS-C3750X-48PF-S)
2. Provide two (2) GbE port (3KX-NM-1GGLC-SX)
3. Provide two (2) GLC-SX-MM

H. Fiber Jumper Cables: (The cable lengths listed below are only to be used for planning purposes. Before ordering cables, the contractor should determine the cable lengths appropriate for the task.)

1. Provide fifteen (15) Multimode Duplex Fiber Jumper, 3-Meter MM LC-LC
2. Provide seventeen (17) multimode Duplex Fiber Jumper, 10-Meter MM LC-LC.

I. Wireless Network Components – New Equipment Located on Third Floor Only

1. Provide four (4) Cisco AIR-CAP 3502l-AK910 802.11a/g/n Ctrl-based 10APs w/CleanAir, Int. Ant; A Reg Domain
2. Provide one (1) WCS-APBASE 50 WCS-Standard-K9 50 Aps. License Only
3. Provide one (1) CON-SA-U-WCSAB50 SW APP SUPP + UPRG WCS Base License for 50 Aps.
5. Fiber Jumper, 3-Meter

J. Wireless Network Components – Existing Equipment Located on First and Second Floors

1. The Owner shall furnish (85) eight-five existing Cisco AIR-LAP1242AG-AK9 wireless access points with existing bracket to this contractor for installation in locations as shown on drawings on the first and second floors. Access points shall be removed by the Owner prior to demolition commencing in building and shall be stored off-site by the Owner until the building is ready for reinstallation of access points by this contractor. Owner shall furnish all brackets to this contractor for installation of access points.

2.3 PERFORMANCE AND FEATURES: (WIRELESS NETWORK) CISCO 3500 CLEANAIR 802.N

A. Equipment shall operate in the 2.4 to 2.4835 GHz.

B. Air Access: Mandatory Complementary Code Keying (CCK) and Orthogonal Frequency Division Multiplexing (OFDM), Optional Packet Binary Convolution Coding (PBCC) and CCK/OFDM

C. Components shall utilize direct sequence spread spectrum (DSSS) modulation.

D. Data Rate: up to 54 Mbps Compatibility: Backward compatible with 802.11b. not compatible with 802.11 FHSS, Infrared (Ir), or HomeRF.

E. Equipment shall support SNMP management and configuration.

F. Equipment shall support roaming between access points. Roaming shall be seamless and transparent to the user.
G. Equipment shall support “seamless” bridging and point-to-point communication between buildings on campus.

H. Equipment shall support wireless Ethernet extensions from printers, Macintosh computers, Apple computers, etc.

I. IEEE 802.11 specifications and/or guidelines for wireless LANs.

J. Support either peer-to-peer or client-server network configurations (or mixed).


L. All WLAN components proposed shall support complete intra-classroom roaming with store and forward technology for support of all user nodes.

M. All WLAN components proposed shall be all equipment (hardware, software, and firmware) required for a WLAN Hybrid solution.

N. Equipment must have the ability to manage a large number of wireless devices from a central location. Also must have the ability to perform upgrades to firmware, make changes to security setting, configuration settings, and provide remote troubleshooting capabilities.

PART 3 - EXECUTION

3.1 SCOPE OF INSTALLATION CATALYST 3750

A. Cisco Catalyst 3750 Series Ethernet Switch(s) with Enhanced Image Software to support multicast.

B. The Cisco Catalyst 3750 Series Ethernet Switch(s) are fixed-configuration, stackable standalone switch(s) that provide wire-speed Fast Ethernet and Gigabit Ethernet connectivity.

C. The Cisco Catalyst 3750 Series Ethernet Switch(s) shall be provided with Enhanced Image Software to deliver intelligent services such as rate limiting and security filtering for deployment at the network edge.

D. The Cisco Catalyst 3750 Series Ethernet Switch(s) shall be installed in each IDF and shall be connected to the Cisco Catalyst 6509 Series Switch via gigabit uplinks located in room A115a. The contractor shall provide and install the required GIB modules. The contractor shall provide and install the stacking cables as required.

E. Scope of Installation

1. Flash switch(s) to the latest version of IOS.
2. Mount in rack
3. All Catalyst 3750 switch(s) must be labeled, inventoried, asset tagged, and configured using QVSD templates and asset tags.
4. The inventory of the 3750 switch(s) must be provided to QVSD in MS Excel format. The format of this spreadsheet will be agreed to by QVSD.
5. All patch cables must be installed so that there is a direct correlation between switch port numbers and data drop numbers as specified by QVSD.
6. The contractor will be responsible for fiber patching the new switches to the Catalyst 6509 switch blade.

F. Cabling Requirements

1. Multi-mode fiber patch cables will be required.
2. Provide and install appropriate length copper patch cables to activate copper patch panel port to Network switches. Cable lengths must be appropriate in that they are not excessively long or short.
3. Cable labels will be required (for switch-switch) uplink ports. QVSD will provide the labeling scheme. The contractor will install these labels and verify accuracy.
4. Data ports should be patched with Gray patch cables. Wireless AP’s should be patched with Royal Blue cables. Special applications should be patched with Green cables.

3.2 SCOPE OF INSTALLATION CISCO WIRELESS ACCESS POINT

A. Cisco Aironet Series 1142 Wireless Access Point – 802.11n

1. The access point shall offer up to 300 Mbps data rates while maintaining full backward compatibility with legacy 802.11 devices.
2. The access point shall be capable of being configured to support both 802.11g and legacy 802.11b clients for investment protection or, for higher performance; it shall be capable of being configured to support only 802.11n clients.
3. The access point shall provide for integrated diversity dipole antennas and an innovative mounting system for easy installation and reliable coverage in a variety of locations and orientations.
4. The access point shall be WI-FI certified and meet the industry security standards with support for 802.1x, WPA, TKIP, and MIC.
5. The access point shall support carrier Sense Multiple Access with Collision Avoidance (CSMA/CA).
6. The access point shall be provided with Power over Ethernet [POE] from a Catalyst 3750X PoE device installed in the appropriate MDF and/or IDF.
7. The wireless network shall provide for 100% coverage of all classrooms. (General distance limitation of an access point wireless cell is an approximate 60 ft radius with a 10% - 15% coverage overlay of access points.
8. All wireless access points shall be installed under the lay-in ceiling unless otherwise specified by QVSD. In locations without lay-in ceilings, the AP shall be placed 8’-10’ above finished floor level.
9. Wireless Access Points installed in outdoor environments shall be designed for the outdoor environment.

B. Cisco CleanAir Series 3500 Wireless Access Point – 802.11n

1. The access point shall offer up to 300 Mbps data rates while maintaining full backward compatibility with legacy 802.11a and g devices.
2. The access point shall be capable of being configured to support both 802.11g and legacy 802.11a clients for investment protection or, for higher performance; it shall be capable of being configured to support only 802.11n clients.
3. The access point shall provide for integrated diversity dipole antennas and an innovative mounting system for easy installation and reliable coverage in a variety of locations and orientations.
4. The access point shall be WI-FI certified and meet the industry security standards with support for 802.1x, WPA, TKIP, and MIC.
5. The access point shall support carrier Sense Multiple Access with Collision Avoidance (CSMA/CA).
6. The access point shall be provided with Power over Ethernet [POE] from a Catalyst PoE device installed in the appropriate MDF and/or IDF.
7. The wireless network shall provide for 100% coverage of all areas of the facility (cafeteria, gymnasium, library, etc).
8. General distance limitation of an access point wireless cell is an approximate 60 ft radius with a 10% - 15% coverage overlay of access points.
9. All wireless access points shall be installed above the lay-in ceiling using manufacture mounting brackets unless otherwise specified by BPSD. The access point shall be installed as close to the ceiling as possible. Depending on ceiling height, the access point may be required to be installed face down. In locations without lay-in ceilings, the AP shall be placed 8’-10’ above finished floor level.
10. Wireless Access Points installed in outdoor environments shall be designed for the outdoor environment.
11. Has the capability to detect (at AP level) analyze and classify RF and Wi-Fi interference activity and preemptively address and report such activity in real time and historically; i.e. Cisco SAgE (Spectrum Analysis Engine). These tools should be sophisticated to the point that they can reasonably identify specific interfering device to be AP, microwave oven or other and list specific frequency, direction and strength of interfering signal.
12. Using Cisco M-Drive solution and Cisco ClientLink technology or equivalent, solve one of the key challenges associated with 802.11n adoption by extending the useful life of existing 802.11a/g devices and minimums “throughput throttling” by slower clients in a mixed a/g/n client environment.
13. Associated with the wireless access points will be included software management tools that have but not limited to the following capabilities or equivalent as seen in the Cisco Clean Air product offering:
   a. Management of AP settings
   b. Auto-configure AP settings
   c. Location identification and mapping of APs
   d. Spectrum management
   e. Interference identification
   f. “Air quality” performance alerts
   g. Map-based visualization
   h. Security alerts
   i. Migration and deployment capabilities
   j. Access point analysis

C. At a minimum, the following locations shall be provided with a wireless access point:

1. MDF - One (1) access point, with its radio turned off, shall be Cisco 3500e Access Point (with external antenna for both 2.4-GHz and 5-GHz Dipole antennas).
2. Classrooms - Wireless Access Points Cisco 1142 shall be located throughout the classroom wings to provide for a minimum of 10 megabit throughput for each student connected to the network. Each classroom has the potential of 26 students accessing the
network simultaneously throughout the day. It is the contractor’s responsibility to verify field conditions to determine the exact quantity of access points necessary. Each classroom is wired to accept 2 access points per room if required (see contract drawings for exact locations) each classroom will be equipped with a minimum of one (1) access point.

3. Library - Access points shall be appropriately located to cover the entire Library. Provide service for the potential of 52 student laptops connecting to the network. The library is wired to accept four (4) Cisco 1142 access point if required (see contract drawings for exact locations).

4. Computer Labs - Two (2) Cisco 1142 access points shall be appropriately located in each typical Computer Lab.

5. Administration Area - Cisco 1142 access points shall be appropriately located to cover the entire administration area refer to contract drawings for locations.

6. Gymnasium - Three (3) Cisco 3500e (with external antenna for both 2.4-GHz and 5-GHz Dipole antennas) access points shall be appropriately located to cover the entire gymnasium (see contract drawings for exact locations).

7. Auditorium - Nine (9) Cisco 3500e (with external antenna for both 2.4-GHz and 5-GHz Dipole antennas) access points shall be appropriately located to cover the entire auditorium area.

8. Cafeteria and LGI – Each area shall have Four (4) Cisco 3500e (with external antenna for both 2.4-GHz and 5-GHz Dipole antennas) access points appropriately located to cover the entire area.

D. Scope of Installation

1. A preliminary site visit to mark AP locations and assess any installation or coverage issues. The AP locations will be based on 10 megabit per student in all classroom teaching areas as designated by QVSD.

2. Configure AP with set-up information according to the District provided template.

3. Mount antenna and access point in location as shown on the drawings, affix AP label and QVSD asset tags. Access point will be mounted no higher than 12-feet above the floor.

4. Upgrade version of IOS as specified by QVSD.

5. Provide and install 1 blue patch cable to activate AP in network closet to PoE device.

6. Provide and install a 15-foot patch cable from the new AP data outlet located above the ceiling to the wireless Access Point (coil excess cable).

7. Test authentication

8. Test wireless coverage by performing “walkabout” facilities of the Cisco wireless management tools (WLSE) to verify wireless coverage in all areas.

9. Contractor will be responsible for providing documentation (QVSD provided form) that includes inventory information for AP’s, channel numbers, AP name, location, switch connectivity ports identified, MAC address and other items related to installation.

3.3 WARRANTY

A. Upon completion of testing, the manufacturer or his representative shall issue to the Owner a letter of Certification attesting to the fact he has tested and adjusted the system, that all components are properly installed and free of defects and that the system in installed in compliance with this specification and manufacturer requirements.

B. The Contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the
Owner during normal hours. The warranty period shall begin on the date of acceptance by the Owner.

C. The Contractor shall, at the Owner's request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

D. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

E. Contractor shall list the length of any warranties over one-year and all components associated with the warranty.

F. Owner expects the warranty coverage will be no less than the services provided in a full maintenance program at no additional cost to Owner. This includes parts, labor, and on-site maintenance with manufacturer-certified personnel.

3.4 CERTIFICATION

A. Upon completion of testing, the manufacturer or his representative shall issue to the Owner a letter of Certification attesting to the fact he has tested and adjusted the system, that all components are properly installed and free of defects and that the system is installed in compliance with this specification and the manufacturer requirements.

3.5 TRAINING

A. The Contractor shall furnish the services of competent instructors who will give instruction in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented toward the system installed rather than being a general training course. Each instructor shall be thoroughly familiar with all aspects of the subject matter they are to teach. The Contractor shall provide all equipment and material required for classroom training.

B. The training program shall be accomplished in two phases for the time interval specified for each phase.

1. The first phase shall be given prior to the acceptance test period at a time mutually agreeable between the Contractor and the Owner, and shall be at least three (3) hours in length. Operating personnel to be trained in the functional operations of the data network system installed and the procedures that the operators will employ for system operation. The training shall include but not be limited to:

   a. General Networking Configuration
   b. System components
   c. The system functionality
   d. General equipment layout
   e. Programming and Configuration

2. The second phase shall be conducted after system acceptance testing for a period of three (3) hours. The training shall include but not be limited to:
a. Programming
b. Troubleshooting procedures
c. Preventive Maintenance procedures
d. Topics requested by Owner.

3.6 ACCEPTANCE

A. All systems must be installed and functional, test results, documentation, drawings and warranty information provided prior to being accepted.

3.7 INSPECTIONS

A. Two periodic inspections, at no expense to the Owner shall be made within the first year’s guarantee period to ensure satisfactory operation of the system.

3.8 UNIT PRICING

A. Provide a guaranteed lump sum price for the work shown on the drawings and detailed in the technical specifications. Price to include all materials, labor, testing, supervision, preparation of shop drawings and as-built documentation, etc necessary to complete the work.

B. Provide a complete list of unit prices add/deduct for all components with: total quantities, total installed cost (including labor) must be included.

END OF SECTION 27 2100
SECTION 27 4113 - ARCHITECTURALLY INTEGRATED AUDIO-VIDEO EQUIPMENT

PART 1 - GENERAL

1.1 OVERVIEW

A. The owner requires a digital video distribution system that will deliver live and stored video to computers and set top boxes utilizing the new data (IP) network.

B. The video shall also be able to be recorded to a video on demand (VOD) server.

C. A portable video unit is required that can stream events to the school network and the public internet simultaneously, and be recorded to the VOD server for later viewing. Examples of events include morning announcements, classes, video conferences, plays, ceremonies, graduations, sporting events, etc.

D. The video solution shall handle simultaneous licensing for 20,000 concurrent users each year for the next 10 years.

E. All the streaming from the live encoders, VOD server, portable video unit, and scheduled programs, must be viewable at any computer on the data network.

F. The video Solution shall come from an ISO certified Manufacturer.

G. The video Solution shall have all proper licensing for any players or software required throughout the solution. Proof of proper licensing shall accompany this bid. Any licensing agreements that shift the responsibility to the owner are not permitted.

H. The manufacturer shall provide the owner with certification by a third party agency, their Video Solution is TEACH Act complaint. Simply saying the equipment can be TEACH Act compliant is not sufficient.

I. Students and faculty will access the live, stored and scheduled video from a common Video Portal that looks and acts the same on computers and TVs. The VBrick Video Portal is password protected and controls all viewing, recording, publishing, scheduling and other privileges.

   1. A separate IP or analog network shall not be used.
   2. Stored video shall come from a true Video on Demand server with very low delay, and support true FF and RW video controls.
   3. The video distribution system must abide by federal laws and deliver closed captioning to computers and set top boxes. It must be Americans with Disabilities Act, section 508, compliant.
   4. A single digital video head end can serve the entire network, regardless of number of users or number of buildings on that network, as long as the IP network is sufficient in those locations.
1.2 RELATED REQUIREMENTS

A. The Drawings, Specifications, General Conditions, Supplementary Conditions and other requirements of Division 1, apply to the work specified in Division 27, and shall be complied with in every aspect. The Contractor shall examine the documents, which make up the Contract Documents and shall coordinate them with the work on the Technology Drawings and Division 27 of these specifications.

B. Please check with engineer before final purchasing of equipment to make sure current parts lists are correct and have not changed since bid award.

C. The contractor will be responsible for the delivery of equipment directly to the site or to the contractor’s staging facility. Under no circumstances, will the District accept any equipment delivered directly to any owner location. If such an attempt is made, the District will order the equipment returned to the manufacturer/distributor at the Contractor’s expense.

D. The contractor will be responsible for verification of receipt of equipment and storage at the site as specified by the contract documents.

E. The contractor must provide a project manager who will be responsible for coordination of all activities of contractor’s staff.

F. The contractor must commit adequate manpower to complete the work within the schedule as set by the contract documents.

G. All installation schedules and procedures must be coordinated with and approved by construction manager.

H. OWNER will provide configuration templates and installation information for all equipment.

I. The contractor will be required to provide the owner with network documentation and should be able to edit documents in Microsoft Visio, Word, and Excel.

J. The contractor shall be responsible for installing and recording owner inventory tags and system serial number information and providing this information in final closeout documentation.

K. The newly installed equipment must meet the industry standards for appearance, neatness, cable dressing, etc.

L. Testing and verification of functionality of the newly installed equipment by the contractor will be required. The owner will provide testing procedures and checklists to be followed.

M. Disposal of all packing materials will be the responsibility of the contractor.

1.3 CONTRACTOR REQUIREMENTS

A. Installation should be performed by a factory trained engineer and have their VNCP (video network certified partner) listing.
B. For Alternate Bids listing alternate manufactures, provide documentation indicating certification with that manufacture.

1.4 CONFLICT BETWEEN DRAWINGS AND SPECIFICATIONS

A. It is intended that any contractor furnishing materials or labor necessary for the completion of this specification shall furnish it in compliance with this specification. Where conflict exists with other specifications concerning such materials and labor, this specification takes precedence unless otherwise approved in writing by the District.

B. Drawings pertaining to this specification shall be considered as a part of said specification and shall be a part of the bid documents.

1.5 RELATED WORK PROVIDED BY OTHERS

A. The network hardware associated operating software and application software for the LAN will be provided under section 272100 or furnished by the owner.

B. The personal computers located in the offices and classrooms will be purchased under separate contract complete with NIC cards.

C. The printers located in the offices and classrooms will be provided under separate contract.

D. Data cabling infrastructure will be provided under Section 27 15 00.

E. Data cabinets and racks will be provided under Section 27 11 00.

PART 2 - PRODUCTS

2.1 FUNCTIONALITY

A. The digital video distribution system shall be capable of streaming live or stored video to any PC on the data network with the below requirements

B. The following sections specifically list the acceptable equipment types and items for this project. Proposed equivalent items must meet or exceed these specifications and the specifications of the listed item. In the event a specified manufacturer's part number has changed or is no longer valid, Contractor shall substitute the appropriate equivalent manufacturer’s part number. Owner or Owner’s designate will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to installation. Where quantities are not noted, they may be obtained from the drawings. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished. Any Owner-furnished materials or equipment not installed in the project shall be returned to the Owner. Contractor shall store all materials and equipment in accordance with manufacturers' instructions in a weather-tight, secure enclosure. Contractor shall be responsible for safety and security of all Owner-furnished materials until project is complete and accepted by Owner.
C. All equipment and materials, unless otherwise specified, shall be new, free from any defects, and of the best quality of their respective kinds. All like materials used shall be of the same manufacture, model, and quality, unless otherwise specified.

D. Manufacturer's names are listed herein to establish a standard.

E. To provide compatibility with existing networking equipment, all data networking equipment shall be Cisco or Owner approved equal.

2.2 THE VBRICK VIDEO PORTAL

A. Shall be identical on PCs and Set Top Boxes (STBs) eliminating the need for extra training.

B. Shall provide each user access to closed captioning defined by ADA section 508, for both live and stored video at PC and STBs.

C. The video portal shall look and feel like a common cable TV viewing interface, including:
   1. CATV viewing icons uploaded by the customer
   2. A 14-day outlook guide similar to normal cable TV to show what is playing and allow scheduling of live TV shows 14 days in advance.
      a. This should display the same dynamic information as the normal home cable TV provider would show for their channel listings.
      b. This should be completely dynamic and be updated every day to represent a continuing 14 day window, without any user intervention being required.
         1) An example of the preferred user interface that resembles the home viewing experience is shown at the bottom of this section.

D. Shall be LDAP compatible with Microsoft Active Directory and Novell, and utilize its own MySQL database in conjunction with LDAP. Single Sign On should be supported for Active Directory.

E. Shall support integration with Blackboard to assist in creating custom classes.

F. Shall support Play Lists, My Favorites, and Bookmarks

G. Shall allow teachers and appropriate users to create their own custom video clips by stitching together segments of various videos into a seamless video (example is 2 minutes of video clip A, 50 seconds from video clip B, 10 minutes from video clip C, etc.

H. Shall provide assets determined by LDAP / users login. Assets include:
   1. Dynamic listing of live video channels and mobile video unit.
   2. Must be able to query multiple VOD servers and present a dynamically updated, single unified content listing of stored video assets based on LDAP / login.
   3. One touch Recording privileges from computers and set top boxes based on LDAP / login
   4. Scheduling privileges
5. Moving and renaming content
6. Asset publishing

I. Shall provide proper licensing for each user.

J. Shall manage copyright, stream limits, time stamps, tracking and logging, internet vs LAN usage and be TEACH act compliant.
   1. It is not enough to simply state the video solution as being TEACH act compliant. The owner requires certification by an outside expert source that their solution is TEACH Act compliant.

K. Shall provide full screen viewing AND allow the teacher or student to launch an external player to support viewing multiple things at the same time.

L. Shall be able to provide clustering support for limitless amount of VOD servers or live video encoders.

M. Shall support internet delivery of Windows Media video by recognizing IP address scheme in addition to login and password.

N. The VBrick Video Portal shall support true Yahoo / Google style searches for appropriate content.

O. The Video Portal shall be able to link to external documents, such as tests, homework, etc.

P. The Video Portal shall support customized search fields determined by the owner, such as Ms. Brown’s class, History 501, etc.

Q. The Video Portal shall automatically determine if any desktop components are needed and automatically push and install components to eliminate manual installation of desktop software.

R. The Video Portal shall support emergency messaging to all PCs with a touch of a button.

S. The Video Portal shall be able to control select set top boxes and TVs to enforce students and staff to watch emergency messages.
   1. Automatically turn on TVs where required (via the TVs IP connection or via IP to IR conversion if its an older TV)
   2. Automatically tune the set top boxes into the appropriate channel for emergency messages.
   3. If a set top box is tuned into a different channel, it will automatically tune into the emergency message.

2.3 LIVE VIDEO APPLIANCES

A. No proprietary or video in special wrappers shall be allowed.

B. Live video shall be encoded into Windows Media format for ease of use with third party products.
C. Owner will specify amount of live channels desired. Modular pricing is requested.

D. Live video encoder shall be able to accept any baseband analog video source (TV camera, document camera, cable TV, etc) for distribution onto the IP network.

E. Live video channels will be encoded and distributed by a robust appliance. The owner does not wish to manage a server farm, thus computers with video encode cards shall not be accepted.

   1. An appliance is designated as having a Real Time Operating System (RTOS). Computer operating systems such as XP or Server, that require patches and virus updates are a drain on administrators and will not be accepted. The owner does not wish to manager a computer or server farm.

F. Encoding appliance must have pass through capabilities via RS-232 for passing through control to external equipment, such as VCRs, DVDs.

G. The robust appliance shall be capable of encoding and distributing video on their own. It should not need the use of a secondary server, such as a reflecting or separate multicast server for video distribution on LAN.

H. Windows Media encoding appliance shall support IGMP and CGMP for distribution on the LAN and support HTTP for the internet and be capable of streaming in all the above formats at the same time to support a variety of network and uses requirements.

I. Windows Media shall support delivery to the public internet via HTTP.

J. Must support multi bit rate encoding for internet distribution.

   1. Three individual video resolutions and bandwidth rates.
   2. Each should be selectable from 20k to 4meg with various resolutions up to 640 x 480.
   3. Must be compatible with the MCS / Video Portal

2.4 VIDEO ON DEMAND (VOD)

A. Video on demand shall be accessed through the MCS / Video Portal designated above.

B. VOD servers should meet these requirements

   1. Support streaming of 300 simultaneous VOD streams or 300mbps of throughput
   2. Support Multi Bit Rate (MBR) VOD.
   3. Have 1.2TB internal storage, when formatted for Raid 5, yields approximately 900mb of usable video storage.
   4. Have a Raid 1 (mirrored) operating system for fault tolerance.
   5. Support multiple schools buildings
   6. Support a clustered arrangement if the owner should expand in the future.

C. Video on demand should support video delivery to PCs and Set top boxes.

D. Video on demand should support FF /RW /pause /play, etc functionality for true user control.
E. Video on demand shall support actual streaming delivery of video files. FTP or progressive downloads causing network spikes shall not be allowed for video delivery.

F. VOD shall be robust and support hot swappable drives and maintain streaming throughput while rebuilding a drive incase of failure.

G. All recorded video shall reside on the VOD server. When a teacher or student records video, it shall not be resident on their local PC.

H. VOD servers shall also be able to multicast streams for mass viewing, such as pre recorded emergency messages, or pre recorded announcements.

I. VOD must be able to support simultaneous streaming and video recording for video-on-demand operation. This includes any processes associated with recording such as ingestion.

2.5 VIDEO RECORDING

A. The video distribution system must be able to record ten (10) simultaneous video streams, while at peak usage conditions. (VOD server is pushing 300 simultaneous VOD sessions and recording 10 streams, and ingesting all at the same time.)

B. Recording capabilities must be LDAP controlled.

C. Recording capabilities must not negatively impact other video distribution functions. Meaning the system must be able to run at full capacity of VOD throughput and other elements in addition to supporting 10 simultaneous recordings.

2.6 SCHEDULING

A. A complete scheduling system shall be accessible through the Video Portal, based on user permissions defined in LDAP and the MySQL database in the VBrick Video Portal.

B. Scheduling system shall support an easy to use calendar that displays monthly, weekly and daily views.

C. Scheduling system shall work with every component of the video distribution system.

D. Support scheduling of a Live Broadcast

E. Support scheduling of a Stored Broadcast

F. Support scheduling a Recording

G. Support scheduling a Script, such as turning on / off supported TVs.

H. All the scheduling components shall be fully adjustable for various reoccurrences and start / end times. For example: Reoccur every Tuesday morning from 8:15am to 8:30am, starting on October 10 and lasting for 6 weeks.
2.7 IP RECEIVERS (STBS)

A. Provide set top boxes (STB) at the flat panel displays in Nurse Waiting B214, E-Learning B215 and Administration Waiting C200. Provide two additional spare IP receivers (STBs) for future video distribution where required.

B. The IP receivers must be appliances.
   1. Computers that require patches, virus updates, and are prone to theft are not acceptable.
   2. The owner does not wish to manage a server or computer farm and deal with the issues surrounding computers being used at TVs. (long boot times, calls to support because it doesn’t boot properly, etc)

C. The system set top boxes must work with the Emergency Messaging system in the video portal.
   1. They are to automatically see the emergency announcement and switch users to viewing that channel.
   2. They should also be able to control TVs (on/off, etc) where designed/appropriate.

D. The system set top boxes must be wall mounted at the TV’s location on a shelf/bracket furnished by the contractor.
   1. They are to mount as close or be part of the LCD monitor wall bracket as practical.
   2. Contractor shall furnish and install a Peerless Parmount PS 200 component shelf to include a Peerless safety belt, part # Acc322.

2.8 PODCASTING

A. All the recorded video should be “PodCast” able.
   1. Conversion from Windows Media to MPEG 4
   2. RSS feeds and information to support the Public Apple Itunes and private PodCasting servers.
   3. Works with audio and video.
   4. Allows users to “subscribe” to any such PodCast via publicly available Apple ITunes.

2.9 DVD/VCR PLAYER

A. DVD/VCR:
   1. Pro-grade combo DVD-R recorder & S-VHS deck for dubbing, archiving & specialized playback applications. DVD recording media: DVD-RAM, DVD-RW, and DVD-R. Simultaneous recording function records programs on both DVD and VCR decks from the same input source. The DVD/VCR shall support RS-232 control.
   2. Rack mount the DVD player in room A115a with other VBrick equipment.
   3. Acceptable products: Two Toshiba D-VR660 DVD Recorder/VCR Combo T24-9115 or equal (include Middle Atlantic RSH series custom rack mount)
PART 3 - INSTALLATION

3.1 INSTALLATION

A. Installation should be performed by a factory trained engineer and have their VNCP (video network certified partner) listing.

B. Video system resellers should show competence by listing references with similar systems.

C. Video system resellers should show competence of Quaker Valley School District’s current data network, since the video distribution system will be utilizing that network.

D. The video system reseller will need to work with the data system reseller who installs the data network to properly set up and install both the Video distribution system and the data distribution system.

3.2 WARRANTY

A. Upon completion of testing, the manufacturer or his representative shall issue to the Owner a letter of Certification attesting to the fact he has tested and adjusted the system, that all components are properly installed and free of defects and that the system in installed in compliance with this specification and manufacturer requirements.

B. The Contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner during normal hours. The warranty period shall begin on the date of acceptance by the Owner.

C. The Contractor shall, at the Owner's request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

D. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

E. Contractor shall list the length of any warranties over one-year and all components associated with the warranty.

F. Owner expects the warranty coverage will be no less than the services provided in a full maintenance program at no additional cost to Owner. This includes parts, labor, and on-site maintenance with manufacturer-certified personnel.

3.3 CERTIFICATION

A. Upon completion of testing, the manufacturer or his representative shall issue to the Owner a letter of Certification attesting to the fact he has tested and adjusted the system, that all components are properly installed and free of defects and that the system in installed in compliance with this specification and the manufacturer requirements.
3.4 TRAINING

A. The Contractor shall furnish the services of competent instructors who will give instruction in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented toward the system installed rather than being a general training course. Each instructor shall be thoroughly familiar with all aspects of the subject matter they are to teach. The Contractor shall provide all equipment and material required for classroom training.

B. The training program shall be accomplished in two phases for the time interval specified for each phase.

1. The first phase shall be given prior to the acceptance test period at a time mutually agreeable between the Contractor and the Owner, and shall be at least (8) hours in length. Operating personnel to be trained in the functional operations of the data network system installed and the procedures that the operators will employ for system operation. The training shall include but not be limited to:
   a. General Networking Configuration
   b. System components
   c. The system functionality
   d. General equipment layout
   e. Programming and Configuration
   f. System Administration

2. The second phase shall be conducted after system acceptance testing for a period of three (4) hours. The Media Specialist training shall include but not be limited to:
   a. Programming
   b. Troubleshooting procedures
   c. Preventive Maintenance procedures
   d. Topics requested by Owner.

3. Curriculum Integration (three full day sessions) covering the following:
   a. Begin the creation of quality content
   b. Develop a replicable process for content development
   c. Create a team of advocates within the district

3.5 ACCEPTANCE

A. All systems must be installed and functional, test results, documentation, drawings and warranty information provided prior to being accepted.

3.6 INSPECTIONS

A. Two periodic inspections, at no expense to the Owner shall be made within the first year’s guarantee period to ensure satisfactory operation of the system.
3.7 EQUIPMENT TOTALS

A. OWNER requests these components to form a complete solution. It is essential all these components work seamlessly together and on the data network. The requirements for these components were outlined above.

B. The following Base Components shall be provided but not limited to:


3. One Model 8000-0174E VBrick Enterprise Media System Network Video Recorder, which records up to 10 simultaneous streams.

4. One Model 8000-0075 VOD 300W – Video on Demand Software with Server for MPEG Content (300 Mbps). Integrated with VBrick’s Portal Server, VBrick Encoders, Windows and MAC based desktop computers and the IP Receiver. Server with Windows operating system provides up to 300 Mbps streaming.


6. Eleven (11) Model 9200-4210-000, 7102 H-HD H.264 High Definition Enterprise Class single channel encoder. Metal enclosure with buttons and display on front panel. Includes SD/HD/3G/SDI, HDMI and YPbPr Component Video inputs. Provide encoders for ten (10) live CATV video channels for multicast distribution of cable TV on the data network streaming H.264 HD, and one additional unit for Media C108D (TV Studio).

7. (15) Model 8000-0155 H.264 HD Set Top Box.

8. Two Toshiba DVR660 DVD Recorder/VCR Combo with RS-232 Control. Provide one Middle Atlantic RSH series custom rack shelf for each DVD Recorder/VCR Combo.

9. One cable and connector for each tuner to integrate the proposed equipment to the school district supplied tuners and IP network.

10. One installation of all proposed equipment and software.

11. One (1) Year Maintenance on all equipment and Software Upgrades. Maintenance must include on-site support, Help Desk, next day parts replacement, software warranty.

END OF SECTION 27 4113
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SECTION 27 4123 - AUDIO-VIDEO ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Drawings, Specifications, General Conditions, Supplementary Conditions, and other requirements of Division 1, apply to the work specified in Division 27, and shall be complied with in every aspect. The Contractor shall examine the documents, which make up the Contract Documents and shall coordinate them with the work on the Technology Drawings and Division 27 of these specifications.

1.2 SUMMARY

A. Provide labor and materials required to design, procure, deliver, install, test, train, commission, program and place into operation the audio and video systems as called for in the contract documents, and according to applicable codes and regulations.

B. Furnish and install all labor, materials, apparatus, and appliances essential to the complete functioning of the systems described and/or indicated herein, or which may be reasonably implied as essential whether mentioned in the Contract Drawings and Specifications or not.

C. Work Provided By Others (Electrical Contractor under Division 26).

1. The scope of work provided by electrical contractor includes but not limited to: furnishing and installation of conduits, back boxes and all miscellaneous hardware (whether specified or not) (e.g. nuts, bolts, tie wraps, fasteners, etc.) for all audio and video systems in locations shown on Architect/Engineer drawings and/or called for whether in specifications, or Contractor other documents specifying the scope of work.

2. Electrical Contractor shall provide dedicated power outlets at locations shown on the Architect/Engineer drawings.

3. General Contractor shall provide Reinforced backing within the wall structures for Over-Sized Flat Panel Monitors where applicable.

D. Division 27 Contractor shall furnish switches, faceplates, and all associated cables from the teacher station and presentation station to the projector location.

1. Contractor shall furnish the projector and mount as listed on the contract drawings.

2. Contractor shall furnish the faceplate and cable for video, audio and control from the teacher’s location and the presentation station to the projector.

3. Contractor shall furnish and install two to four ceiling mounted speakers in each classroom as indicated on the drawings.

4. Contractor shall furnish and install the projector wall mounting bracket and a supporting hardware to connect to the projector.

E. System components included herein, but not limited to, the following:

1. Wiring
2. Projectors and mounts
3. Connecting Cables
4. Flat Panel Televisions
5. Camera System (Room C110)
6. Portable RF Assisted Listening Systems

1.3 CONTRACTOR QUALIFICATIONS

A. Manufacturer Qualifications: The Manufacturer or Supplier fabricating the material or equipment described in this Section must, within the last five (5) consecutive years, have successfully completed in a timely fashion at least two (2) projects similar in scope and type to the required work for this Section.

B. Installer Qualifications: The Contractor performing the Work of this Section must, within the last five (5) consecutive years, have successfully completed in a timely fashion at least three (3) projects similar in scope and type to the required work for this Section.

C. The Contractor performing the Work of this Section may demonstrate compliance with the above qualification requirements by demonstrating that it is certified or authorized as an installer by a manufacturer designated as acceptable in these Specifications. A copy of such manufacturer certification or authorizations must be submitted, or verified in writing by the manufacturer.

1.4 SUBMITTALS

A. Submit shop drawings, wire markings, all manufacturer's data, samples and test procedure and reports as called for hereinafter. All submissions to be in English Language. All submittals require the approval of Owner/Engineer.

B. Submit a single guarantee stating that all parts of the work are in accordance with Contract requirements. Guarantee work against faulty and improper material and workmanship for a period of one (1) year from date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are specified herein, such longer term to apply. Within 24 hours after notification, correct any deficiencies, which occur during the guarantee period at no additional cost to the Owner, to the satisfaction of the Owner and Engineer. Obtain similar guarantees from subcontractors, manufacturers, suppliers and sub-trade specialists, if any.

C. Indemnify the Owner and the Architect/Engineer against loss, liability, damage or expense, including attorneys' fees, in connection with any claim resulting from damage, which may be asserted by any third party.

1.5 OWNER'S MANUALS

A. General:

1. Submit 2 draft copies of owner's manuals for review. After review by authorized representative, the contractor shall incorporate review comments and submit 6 final copies.
2. Update manuals with modifications made to system during guarantee period. Provide replacement pages or supplements in quantity stated above.
3. Assemble owner's manuals into multi-volume sets as necessary and required by the Owner.
4. Protect each volume with a heavy-duty vinyl plastic binder. Volumes to have plastic printed dividers between major sections and have oversized binders to accommodate up to 2 inch thick set of additional information.
5. Each binder to be silk-screened with project name and volume title on front cover and binder.
6. On the first page of each manual identify with project name, manual title, owner's name, engineer's name, contractor's name, address and service phone number, and person who prepared manual.

B. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:

   1. Sequence of operation for on-line and off-line operating modes. The sequences shall cross-reference the system point names.
   2. System manufacturers complete operating manuals.

C. Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:

   1. Complete as-built installation drawings for each system.
   2. Photographs and drawings showing installation details and locations of equipment.
   3. Routine preventive maintenance procedures, corrective diagnostic troubleshooting procedures, and calibration procedures.
   4. Parts list with manufacturer's catalog numbers and ordering information.
   5. Manufacturer's operating set up, maintenance and catalog literature for each piece of equipment.
   7. Recommended spare parts.
   8. Field test reports.

D. Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:

   1. Complete programming manuals, and reference guides.
   2. Details of any special software packages supplied with system.
   3. Information required for independent programming of system.
   4. Software troubleshooting procedures.

1.6 QUALITY CONTROL

A. Quality Assurance:

   1. Comply with current governing codes, ordinances and regulations, and all other applicable codes.
2. Comply with the requirements of agencies or authorities having jurisdiction over any part of the work and secure all necessary permits.
3. The products shall be compliant with test reports, such as ISO-9001, ISO-9014, UL1950, or CE conforming to the rigid EMC requirements for electromagnetic emissions, immunity, and harmonics where applicable.
4. Where codes or standards are listed herein, the applicable portions apply.
5. Plans, specifications, codes and standards are minimum requirements. Where requirements differ, apply the more stringent.
6. Should any change in plans or specifications be required to comply with governing regulations, notify the Architect/Engineer at the time of submitting the bid.
7. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workmanlike manner by competent workmen. Provide a competent, experienced full-time Superintendent who is authorized to make decisions on behalf of the Contractor.
8. Equipment and materials supplied shall be complete, model numbers accurate, and the performance shall conform to manufacturer's specifications.
9. All equipment and materials shall be new and shall conform to applicable codes.
10. Repair or replace any items damaged during installation.
11. Procure and pay for all necessary permits, licenses, inspections, and observe any requirements stipulated therein.
12. The installation shall conform to the latest safety codes and regulations. Where conflicts exist, the most stringent code or regulation shall apply.
13. Adhere to all Quality Assurance items in the Sub-Contract Agreement issued by the Construction Manager.

B. Assurance:

1. Comply with current governing codes, ordinances and regulations, and all other applicable codes.
2. Comply with the requirements of agencies or authorities having jurisdiction over any part of the work and secure all necessary permits.
3. The products shall be compliant with test reports, such as ISO-9001, ISO-9014, UL1950 or CE conforming to the rigid EMC requirements for electromagnetic emissions, immunity and harmonics where applicable.
4. Where codes or standards are listed herein, the applicable portions apply.
5. Plans, specifications, codes and standards are minimum requirements. Where requirements differ, apply the more stringent.
6. Should any change in plans or specifications be required to comply with governing regulations, notify the Architect/Engineer at the time of submitting the bid.
7. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workmanlike manner by competent workmen. Provide a competent, experienced full-time Superintendent who is authorized to make decisions on behalf of the Contractor.
8. Installer Qualifications: The Contractor performing the Work of this Section must, within the last five (5) consecutive years, have successfully completed in a timely fashion at least three (3) projects similar in scope and type to the required work for this Section.
9. The Contractor performing the Work of this Section may demonstrate compliance with the above qualification requirements by demonstrating that it is certified or authorized as an installer by a manufacturer designated as acceptable in these Specifications. A copy of such manufacturer certification or authorizations must be submitted, or verified in writing by the manufacturer.
10. Equipment and materials supplied shall be complete, model numbers accurate, and the performance shall conform to manufacturer's specifications.
11. All equipment and materials shall be new and shall conform to applicable codes.
12. Repair or replace any items damaged during installation.
13. Procure and pay for all necessary permits, licenses, inspections, and observe any requirements stipulated therein.
14. The installation shall conform to the latest safety codes and regulations. Where conflicts exist, the most stringent code or regulation shall apply.
15. Adhere to all Quality Assurance items in the Sub-Contract Agreement issued by the Construction Manager.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factor containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

B. The work covered in this document consists of furnishing all labor, material and services necessary to install a complete audiovisual system as indicated on the project drawings and in these specifications.

C. Deliverables:

1. Prior to ordering materials or commencing any construction activities, the contractor shall provide the Owner with a complete bill of materials, including all quantities of components, devices, equipment, and wiring required to complete this work. Submit product data, including manufacturer’s data sheets for all proposed system components. Submit three copies with all specific items that will be provided clearly indicated and any options highlighted.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PROJECTOR MANUFACTURERS

A. Hitachi
B. Mitsubishi
C. Panasonic
D. Sanyo

2.2 SYSTEMS DESCRIPTION

A. Provide a complete Audiovisual System for small to medium sized classrooms. The system switching and audio amplification equipment shall be securely mounted and concealed in an enclosure above the ceiling. Portable video source equipment (OFE) can be connected to the system and displayed via three interface panels located throughout the room. Video and audio
signals from source devices shall be transmitted from the interface panels over standard UTP cabling architecture.

B. Owner Furnished Equipment (OFE)

1. In each system, the video source equipment shall be furnished by the Owner (OFE). Portable source equipment such as DVDs, VCRs, laptop computers, document cameras, etc. shall be owner furnished except where identified on the contract drawings.

2.3 GENERAL EQUIPMENT REQUIREMENTS

A. Acceptable products are listed below categorized by type of equipment. Quantities are listed for movable, portable or loose equipment, and other selected entries. Where quantities are not listed, refer to the system drawings.

B. Deviations from this specification must be documented in writing to the Architect and Owner at least ten business days prior to the bid date.

C. The System components shall all be listed and labeled by Underwriters Laboratories Incorporated (UL).

D. All products shall be new and under warranty at the time of installation. B-stock, previously installed, refurbished or used equipment shall not be provided on this project.

E. Where the specification lists several manufacturers for a major item, or group of items, the AV Integrator shall provide that entire item from one manufacturer only.

F. The contractor shall provide all options, accessories and hardware necessary to meet the function of the design even if they are not specifically listed (i.e. mounting kits, separate or additional power supplies, input modules, transformers, etc.).

2.4 FIXED and PORTABLE EQUIPMENT

A. 42" Flat Screen TV LG 42LE5400 with Premier Mounts P2642 wall bracket for mounting (Quantity as per drawings)

B. 65" Flat Screen TV LG UN65C6500VF with Premier Mounts P5080T wall bracket for mounting (Quantity as per drawings)

1. The system set top boxes where applicable must be wall mounted at the TV’s location on a shelf/bracket furnished by the contractor. These boxes are to mount as close or be part of the LCD monitor wall bracket as practical.

C. Microphones (Quantity 12 Total) To be used with Classroom Infrared Systems

1. Head-worn Microphone to Integrate with M1 Infrared Microphone
2. The Head-worn microphone shall be Listen Technologies LA-278

D. Portable ADA Hearing Assistance System (Quantity 12 Total)
1. System shall contain all necessary electronics and other equipment as may be required to provide a fully functional and operational system including, but not limited to the following:
   a. (1) LT-800 Stationary FM Transmitter (72MHz)
   b. (1) LA-123 Universal Antenna (72MHz)
   c. (4) LR-500 Portable Programmable Display FM Receiver (72MHz)
   d. (4) LA-164 Ear Speaker
   e. (1) LA-320 Configurable Carrying Case
   f. (4) LA-362 NiMH AA Rechargeable Batteries (pkg. of 2)

E. Ultra Short Throw Projector w/Wall Mount: (Quantity As Per Drawings)
   1. The projectors shall be Hitachi CPAW250N, 2600WXGA Short Throw Projector.
   2. The wall mount shall be Universal Short-Throw Projector Model: UNI-STA manufactured by Premier Mounts.

F. Short Throw Projector with ceiling Mount: (Quantity as Per Drawings)
   1. The projectors shall be Hitachi CPWX8, 2600LWXGA Short Throw Projector.
   2. Include all ceiling mounting hardware PP-FCMA with FTP-W Universal Mount (White) and PWH-4W pole manufactured by Premier Mounts.

G. Flush Ceiling Mount Camera for Room C110: (Quantity 1 Total)
   1. The 540TTL Color Flush Ceiling Mount Camera with Power Supply shall be the: Bosch VDC-455V04-20

H. Provide Digital Signage Player, Software:  AMX Inspired – SPX-1000 with a Kramer VP-501xl Video Scan Converter
   1. Digital Signage Operating Computer to be Owner Furnished.

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment and enclosures described in this specification shall be installed plumb and square per manufacturer’s instructions.

B. All equipment, except that designated as movable, portable or loose equipment, shall be secured and permanently attached to the permanent structure in a manner which will require the use of a tool (e.g.: screw driver, nut driver, etc.) for removal.

C. All supports shall meet or exceed the load requirements of the intended application with a minimum safety factor of five.

D. Provide support structure and hardware with a SAE Grade 8 load rating (min.).
3.2 EXAMINATION

A. Site Verification of Conditions: Verify that related conditions, including equipment that has been previously installed under other sections, are acceptable for product installation in accordance with manufacturer’s instructions.

B. All devices connected to equipment specified in this section shall bear the UL label and comply with the applicable National Electrical Code (NEC) standards.

3.3 INSTALLATION

A. Contractor shall furnish all equipment, labor, system setup, and other services necessary for the proper installation of the products/system as indicated on the drawings and specified herein. System setup information shall include each components proper mounting and alignment and properly verified signal pathways and operation. Proper operational control functions should be verified.

B. Install in accordance with manufacturer’s handling and installation instructions.

C. Install in accordance with all local and pertaining codes and regulations

D. Utilize an installer with demonstrated experience in projects of similar size and complexity.

E. Equipment shall be ready for use to condition at the end of installation.

F. Energize equipment in accordance with manufacturer’s instructions.

3.4 PROTECTION AND CLEANING

A. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

B. Repair or replace damaged components before Substantial Completion of the project.

C. Remove temporary tags, coverings, and construction debris from interior and exterior surfaces of the equipment. Remove construction debris from equipment area and dispose of properly.

END OF SECTION 27 4123
SECTION 27 5120 - INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 27.

B. This section is a Division 27 COMMUNICATIONS Section, and is a part of each Division 27 Section.

C. Requirements of the following Division 27 Sections apply to this section:

1. Section 27 0500 Common Work Results for Communications
2. Section 27 0523 Control Voltage Communication Cabling
3. Section 27 0526 Grounding
4. Section 27 0529 Hangers and Supports for Communication Systems
5. Section 27 0552 Identification for Communication Systems

1.2 SUBMITTALS

A. General: Submit all product data and/or shop drawings bound in a single, soft-cover binder. Incomplete submittals, i.e., missing speakers, volume controls, cable, racks, single-line risers, Contractor’s stamp, etc. will be returned to the sender with any and all appropriate actions being taken. The local sound system submittal shall comply with the following:

1. Complete schedule of ALL equipment and materials that are to be furnished for the work.
2. Provide cover page that includes the Contractors’ and Suppliers’ name, addresses, and telephone numbers, and the name of the Project.
3. Organized and physically divided into sections for each group of items, i.e., separate sections for sound equipment, accessories, single-line riser, etc.
4. Clearly identify each item by highlight marker or arrow to define that specific component, all associated characteristics, and all hardware.

B. Product Data for each type of product specified.

C. Shop Drawings detailing systems including, but not limited to, the following:

1. System layouts.
2. Control panels.

D. Wiring diagrams detailing wiring for power, signal, and control systems and differentiating clearly between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance.
1.3 QUALITY CONTROL

A. Contractor/Installer Qualifications: Engage an experienced Contractor/Installer who is an authorized representative of the specified system manufacturers to perform work of this section. This corporation must be experienced in professional audio and video systems of the A/V nature complying with the requirements of these specifications with at least 2 contracted projects of similar size along with corporate offices located in the state of Pennsylvania registered with a Pennsylvania State of Incorporation operating within the state under the same corporate name for a minimum of 8 (Eight) years.

B. The A/V Contractor must have personnel on staff with current CTS and RCDD Certifications. These certifications as well as copies of individual personnel names/certifications MUST be submitted with bid. This certification ensures that the installation and servicing of all aspects of the system adheres to the code of ethics of the industry standards. Additionally, Manufacturer’s Trained Technicians must be on staff of the successful contractor.

C. An approved systems integrator for this project is:

1. Horizon Information Services
   1659 East Sutter Rd
   Glenshaw, Pa 15116
   (412) 487-7071

1.4 SYSTEM OVERVIEW

A. The system shall consolidate systems typically delivered as separate non-integrated software and hardware applications into a simple user friendly graphically based networked solution. The system shall provide graphical use of building floor plans for the purpose of creating zones or selecting a single and/or groups of rooms for all software sub-functions to be described within this specification. Systems not utilizing graphical floor plans of the campus will not be accepted.

B. The system shall provide simultaneous communication to all classrooms. All broadcast audio and classroom communications shall be via the network backbone. The system shall use industry standard encoding of all audio. Systems utilizing proprietary encoding schemes shall not be acceptable. All system data shall be stored in XML data files that can be retrieved over the network for backup or archival purposes. All visual, audible or e-mail alerts are for the purposes of enhancing existing life safety systems and are not intended as replacements to such systems.

C. The system shall consist of two equipment racks. Each rack will contain equipment described as the IMS audio rack and the video rack. The IMS Audio rack shall contain the master control system in which the software is to be installed. This rack location shall be dedicated to managing building clocks, bells, PA/Intercom, remote microphones, telephone interfaces, background music sources, audio extractor of video sources, and common zone audio. In addition, the system shall control a secondary video rack and all classroom equipment. The secondary rack shall contain a sub-system control unit, which shall control all video source devices to be shared over the network to the entire campus as multicast MPEG2 video streams.
D. Administration Location: Provide a password protected interactive touch panel in the administration area of the school campus. The touch panel shall provide access and control to the system software. System shall provide one wall mounted microphone and one push-to-talk microphone. There shall be a ceiling mounted speaker with an associated volume control. The software shall allow for network access and control of the administrative touch panel from anywhere on the school’s LAN or district WAN.

E. Available Manufacturers: The manufacturers and their associated catalog numbers herein specified constitute the material and desired operating features that are to be furnished. The design of this system is based upon specific components specified herein. The redesign of this system utilizing fewer components will not be acceptable and will result in the rejection of the bid and submittal.

1.5 SOFTWARE MODULES

A. The software shall provide a single integrated solution for control of the following school subsystems directly via the IP Network.

1. Bell System
2. Digital Clocks
3. Audio Paging
4. Background Music
5. 2-Way Intercom Option
6. Remote Audio
7. Teacher’s Web Interface
8. Video Broadcast (DVD, Satellite, Cable, Over-the-Air)
9. Remote Video Broadcast (Campus Studio or Broadcast Cart)
10. Digital Signage
11. Emergency Alert
12. Manage Displays
13. Security Camera Integration
14. Telephone Interface
15. RMS Integration

1.6 BELL SYSTEM

A. The software shall control and broadcast all bell tones over the IP network. Bell tones shall be stored as standard MP3 files and as such may be any type of audio tone, which can include, but not limited to, bell tones, music files in part or full, recorded voice announcements, coded audio messages, or audible alerts. All MP3 files shall be directly accessible by the system touch screen and web interface. The system shall allow for virtually an unlimited number of combinations of rooms and common areas to be saved as named zones with multiple automated schedules. Software shall provide the ability to schedule the bell schedules graphically on a rolling 12-month calendar. MP3 files shall be stored on an easily changeable USB memory stick.

B. Events shall be capable of being triggered by scheduled time, manual button on the touch panel or via a dial-up telephone voice prompted menu.
1.7 AUDIO PAGING

A. The system software shall broadcast live voice announcements via IP network to any and all classrooms and common areas with the existing building and the new additions. The system shall reuse the current corridor and classroom speakers. The system shall allow for a virtually unlimited number of combinations of rooms and common areas to be saved as named zones. Assignment of zones shall be chosen via a graphical floor plan image of the school. Audio paging is available by but not limited to the following:

1. Push-to-talk microphone
2. Desktop telephone
3. Cell phone
4. Stand-alone sound system
5. Remote microphone

B. 2-Way IP Intercom Option: The system software shall be capable of supporting 2-way communication via the network to/from predetermined locations such as a principal’s office, and administration.

C. Background Music: The system software shall control and broadcast live AM/FM, satellite radio, or CD audio to any and all classrooms and common areas via direct IP audio streaming. The system shall allow for a virtually unlimited number of combinations of rooms and common areas to be saved as named zones. The CampusSV® system shall support virtually any RS-232 or IR controllable music source.

D. Classroom Speaker Controls: The system software shall provide direct network management of all classroom speaker zones. Switching of all zones shall be simultaneous. The software shall be capable of overriding volume levels within the classroom. During non-event times, teachers shall have local volume control via a connected keypad, graphical color touch interface, or web-based client software.

E. Remote Audio: Virtually any network data drop shall be an input to the system. The system shall allow the remote audio source to be a standard or a priority audio event. As a standard audio event, the event shall not interrupt normal PA or bell events. As a priority event, the event shall interrupt all other audio events. Remote audio inputs shall support the following input types:

F. Microphones: The system software shall support additional microphones to be connected to any network location via an audio encoding device. This device shall allow for any network jack to operate as a microphone input to the system.

G. Stand-Alone Sound Systems: The system software shall support 2-Way audio from a stand-alone sound system such as a Gym, Music, Cafeteria or Auditorium. The system shall allow for the audio from the location to be routed to any and all zones within the system. The system shall also allow for the stand-alone sound system to receive any PA, bell, or background music event from the system.
1.8 SECURITY CAMERA INTEGRATION

A. The system software package shall allow integration of 3rd party IP based Motion JPEG security cameras to display selected cameras on the touch panel’s security page. This security page will provide for full screen view or quad views of selected cameras. The system will allow for contact closure activation to be assigned to a specific security camera. The contact closure can be made to trigger an audible tone and/or to display the associated camera to full screen on the touch panel. An answer door or release door button can allow for 3rd party relay controlled magnetically locked doors to be released to allow entry. The system software shall also provide pan/tilt/zoom/focus controls for any camera that supports such functions and allows network control.

1.9 CLASSROOM CONTROL

A. The system Teacher web client shall control the local classroom projector, the AV switcher/audio amplifier and classroom video decoding (PeerStation) device via an Internet web browser such as Internet Explorer or Firefox. The software client shall be web based and shall accessible by the teachers PC device located in each classroom. Classroom controls can also be accessed by a 4.3-inch graphical touch panel, an 8 or 16-button keypad.

B. Specific classroom functionality shall include, but not limited to, the following:

1. Projector controls
2. Room volume/mute
3. Local source select
4. Head-end source select and control
5. Favorite channel select
6. Video-On-Demand
7. Intercom control
8. Energy management
9. Tools

1.10 VIDEO BROADCAST

A. The system software package shall broadcast video streaming via IP to any and all classroom projectors and common area flat panels. The system shall allow for virtually an unlimited number of combinations of rooms and common areas to be configurable zones and assigned to standard video sources such as, but not limited to, the following:

1. VCRs
2. DVD players
3. VCR/DVD combination players
4. DVR players
5. Over-the-air digital tuners
6. Cable converter boxes
7. Satellite receivers
8. Verizon Fios receivers

B. The user shall be able to control each source from the admin touch panel, teacher’s web client
or graphical touch interface. Preview of the video shall be available directly on the touch panel or through use of Video Lan’s VLC video player on any connected PC or MAC. A video preview window shall be embedded within the teacher web client. Basic IR controls shall consist of but not be limited to navigation and transport controls.

C. Remote Broadcasting (Video): The system software package shall broadcast video streaming via IP from a mobile broadcast cart(s) or studio(s) to any and all classroom projectors and common area flat panels. The system shall allow for virtually an unlimited number of combinations of rooms and common areas to be configurable zones and assigned to the remote broadcast cart(s) or studio(s).

D. Manage Displays: The system software package shall provide network control and management of all classroom projectors. This shall include definition of auto-off times, display of lamp hours, current power status, monitoring for projector health and/or anti-theft alarms. Multiple auto-off time configurations must be available and programmable for multiple zones. The system shall allow for virtually an unlimited number of combinations of rooms and common areas to be saved as named zones. Named zones, groups of rooms or individual rooms shall also be controllable via a direct control interface, which shall include, but not be limited to, the following:

1. Power
2. Input select
3. Favorite channels
4. Default channel
5. Campus video
6. Campus audio
7. Mute audio

E. Digital Signage: The system software package shall allow integration of 3rd party digital signage equipment for the purpose of providing locally produced information broadcasted via IP to each projector and/or flat panel display. The system shall allow for virtually an unlimited number of combinations of rooms and common areas to be saved as named zones. The system shall control all displays for auto-on and auto-off times. Named zones, groups of rooms or individual rooms shall also be controllable via a direct control interface, which shall include, but not be limited to, the following:

1. Power
2. Input select
3. Cable TV/Channel tuning

F. The system shall allow for management of crawl information of the 3rd party digital signage equipment. The user shall be able to enter text directly on the touch panel or web interface. The text shall populate the corresponding slide’s crawl text.

G. Emergency Alert: The system software package shall allow for the broadcast of video emergency alerts or drill messages to any and all projector and flat panel display zones via IP. The alerts/drills shall include at a minimum Lockdown, Weather and Fire. The system shall override current use of the projector by the teacher. The system must allow for custom messages to be entered at the touch panel or web interface for each alert/drill screen. The system shall provide an all-clear message. Emergency alerts shall trigger visual, audible and textual alerts through the connected hardware. After an emergency alert has been cancelled and the all-clear
message has been broadcast, all displays shall return to their previous state. Any systems not returning projectors or flat panels to their previous state shall not be accepted.

1.11 SYSTEM MANAGEMENT

A. The system software package shall provide a system management page which will consist of the following areas:

1. System power management
2. Default volume management
3. MP3 Bell/Tone/Audio/Recorded voice management
4. User access management
5. System time management
6. Push-to-talk microphone zone management
7. Direct phone paging zone management
8. Paging chime management
9. Projector status page
10. E-mail configuration page
11. Panic button management
12. Projector alarm management
13. Manage PC section
14. Manage schedules
15. Manage alerts

B. System Power: The system software package shall allow certain items in the hardware racks to be powered down for the purposes of conserving electricity.

C. Default Volume: The system software package shall allow for individual volume sources to be adjusted to a specific environment such as:

1. Push-to-talk microphones
2. PA microphone
3. Bells
4. Music
5. Phone interface
6. Program
7. Remote audio

D. Manage MP3 Files: The system software package shall allow for display of all MP3 files on the touch screen graphical interface. All MP3 files shall reside on a memory stick in the IMS rack and adjusting the duration of each MP3 file.

E. User Access: The system software package shall allow for management of users and level of accessibility to the system. A virtually unlimited number of users can be added to the system with a unique password. Each user can be given access to any or all of the follow areas:

1. Audio events
2. Audio paging
3. Video paging
4. Manage displays
5. Background music
6. Remote audio
7. Security cameras
8. System management
9. Digital signage
10. Emergency alerts
11. Energy management
12. Dial-in access

F. System Time: The system software package shall allow for access to the Internet and networked time servers for the purpose of retrieving networked time information and providing accurate time to all RS-232 clocks on campus. The system shall provide an internal clock in the event networked time information is not available.

G. Push-To-Talk Microphone: See audio paging.

H. Direct Phone Paging: See audio paging.

I. Alerts: The system software package shall provide for system alerts which shall be audible, visual and textual. These alerts can be triggered by contact closures such as doorbell switches or motions sensors. In addition, alerts can be triggered by virtual switches tied to the disconnection of power to projectors or interruption of network communication between the system and the classroom projector. Physical or virtual web call/panic buttons shall be available to every classroom system. Audible alerts shall be available to all PA/Intercom zones and have an assignable MP3 audio file. Visual alerts shall be available on the graphical interface via the touch panel or web client. Text alerts shall be sent to any personnel assigned to receive e-mail alerts specific to the occurrence. The system shall allow for assigning security camera streams to specific triggered occurrences and visible on the graphical interface.

J. Projector Alerts: The system software package shall allow for defining of a start and end time which will establish a period of time for which a trigger can be customized. The customization shall include the assigning of an MP3 tone and a zone for which the MP3 shall be played. There shall be 3 defined times which are Daytime, Nighttime and Holiday. Daytime and Nighttime hours shall be opposite of each other and Holiday times shall be determined by the setting in the “System Power” section and by selecting the “Switching Alerts to Holiday Mode” to the active state.

K. Daytime Scenario: A display managed by the system is disconnected from the network or the power cord is removed. The following shall occur:
   1. An e-mail is sent to selected school personnel
   2. A visual alert is displayed on the touch panel pinpointing the exact location of the occurrence
   3. An MP3 tone shall be played through the PA system to a designated zone setup by the user

L. Response: Campus personnel will hear the specific tone dedicated to display tampering alerts, which will direct them to the visual alert on the touch panel pinpointing the location of the occurrence. An e-mail is sent to all personnel selected within the “E-mail Notification” section.
M. Nighttime Scenario: A display managed by the system is disconnected from the network or the power cord is removed. The following shall occur:

1. An e-mail is sent to selected school personnel
2. A visual alert is displayed on the touch panel pinpointing the exact location of the occurrence
3. An MP3 tone shall be played through the PA system to a designated zone setup by the user
   a. Response: Trespassers shall hear an MP3 audible alarm throughout the building or any zone selected by campus personnel. Campus personnel shall receive an e-mail, alerting them to the projector/display tampering. Utilizing the voice prompted enhanced phone interface, campus personnel can access the password protected voice prompted system from any telephone to access the paging system. With remote PC and school network access the user can access the touch panel to pinpoint the occurrence as to notify authorities. In addition, any motion JPEG IP cameras integrated to the system can be viewed remotely on web interface of the touch panel allowing visual confirmation of intrusion to the campus.

b. Holiday Scenario: In the event the system is set to holiday mode (Done in system power section), all alerts shall ignore daytime or nighttime alert settings and shall trigger holiday alert settings.

N. Panic Button/Office Call: This system software package option shall allow for defining of a start and end time which will establish a period of time for which a trigger can be customized. The customization shall include the assigning of an MP3 tone and a zone for which the MP3 shall be played. There shall be 3 defined times which are Daytime, Nighttime and Holiday. Daytime and Nighttime hours shall be opposite of each other and Holiday times shall be determined by the setting in System Power section and by selecting the “Switching Alerts to Holiday Mode” to the active state.

1. Daytime Scenario: During preset hours such as 8:00 am to 6:00 pm, an instructor can press a physical button within the classroom or a web client button to call a predetermined campus location such as the receptionist desk.
   a. An e-mail may be sent to selected school personnel.
   b. A visual alert is displayed on the touch panel pinpointing the exact location of the page call.
   c. An MP3 tone shall be played through the PA system to a designated zone setup by the user
2. Response: Receptionist desk hears page tone and can view via the touch panel the location of the page call. Utilizing the touch panel interface or web interface the receptionist is able to conduct a 2-way IP based conversation with the classroom location.
3. Nighttime Scenario: During preset hours opposite of the daytime scenario such as 6:00 pm to 8:00 am, an instructor can press a physical button within the classroom or a web client button to sound a tone or audio alarm campus wide.
   a. An e-mail is sent to selected school personnel
   b. A visual alert is displayed on the touch panel pinpointing the exact location of the occurrence
c. An MP3 tone shall be played through the PA system to a designated zone setup by the user

4. Response: Upon triggering the panic button, a preset audio tone can play through the PA system to the entire campus or any selected zone. Selected campus or district personnel shall receive an alert e-mail. Campus or district personnel can access the touch panel web interface to pinpoint the exact location of the occurrence and also access integrated security cameras to view any intrusion.

5. Holiday Scenario: In the event the system is set to holiday mode (Done in system power section), all alerts shall ignore daytime or nighttime alert settings and shall trigger holiday alert settings.

O. Doorbells/ Miscellaneous Alarms: Through the control processor, the system shall receive multiple alerts from devices such as doorbells, motion sensor, door contacts, etc. The system shall allow for defining of a start and end time which will establish a period of time for which a trigger can be customized. This trigger can be activated by a contact closure. The touch panel interface shall allow for assigning an input address to a specific named alert. The customization shall include the assigning of an MP3 tone and a zone for which the MP3 shall be played. There shall be 3 defined times which are Daytime, Nighttime and Holiday. Daytime and Nighttime hours shall be opposite of each other and Holiday times shall be determined by the setting in System Power section and by selecting the “Switching Alerts to Holiday Mode” to the active state. Scenarios and responses are identical to the projector alerts but are assigned to an individual contact closure on campus. This is to provide entry/exit alarms or chimes to the campus.

1.12 E-MAIL NOTIFICATION

A. The software package shall allow entry of e-mail addresses of individuals to receive e-mail alerts for, but not limited to, the following:

1. Panic button alerts
2. Display alerts
3. Door alerts (See manage alerts)

B. The system shall allow for the storage of multiple e-mails addresses of key campus or district personnel. Addresses can be assigned to various triggered alerts for the purposes of notifying campus or district personnel. Alerts can be triggered by physical contact closures (push button), switches, or virtual web button presses.

1.13 ENHANCED TELEPHONE INTERFACE

A. The system software package shall allow ability to access the system from any telephone or cell phone. The phone access will allow for control or access to the following:

1. Manual bells
2. Zoned paging system
3. Manage projectors
4. Emergency alerts
B. Telephone access shall allow for triggering of any of the 6 manual bells that have been configured for zones and have been assigned an MP3 file. The telephone access shall also allow for paging any of the configured paging zones and allow the phone microphone to act as the paging microphone to address any and all zones on campus. The telephone access shall allow the user to power all projectors on or off. The telephone access shall allow the user to trigger any emergency alerts/drills and trigger the all-clear message.

1.14 CLASSROOM SOFTWARE (INTERFACE)

A. Provide a classroom control interface to allow the teacher to control the local classroom Audio/Video system. Various degrees of control shall be available depending on the type of interface provided.

B. Web Client: The teacher web client shall be accessible for both PC and MAC platforms from Internet Explorer, Firefox, and Safari web browsers. This single interface shall be all that is required to access and control the classroom projector, sound system, headend streamed video sources, video-on-demand titles and intercom functionality. It shall also provide PC energy management override features as well as countdown timer and stopwatch.

C. 4.3-inch Touch Screen Control: The application shall be accessible from a 4.3-inch graphical color touch interface. The touch interface shall have an aspect ratio of 16x9 with WQVG resolution. The unit shall be power-over-ethernet capable. Network access to the interface providing a password protected graphical interface on any networked PC or MAC with proper user rights shall be required. Any touch interface not meeting this requirement shall not be accepted.

D. Direct source selection

E. Headend streaming source selection and transport control

F. Provide the system password protected classroom software application to allow the classroom teacher to control the following:

1. Room controls
2. Local source selection
3. Video sources (Headend video selection and control)
4. On-Demand video selection and control
5. Intercom control
6. Energy management
7. Tools

G. Classroom Projector: The system’s graphical classroom interface shall provide basic projector controls, streaming channel selection, default streaming channel selection, room volume control and volume mute.

H. Local Sources: The system’s graphical classroom interface shall provide the capability to switch the projector and audio to local classroom sources such as a classroom computer, VCR, DVD player, document camera, campus video channel, or campus background audio.
I. Video Sources: The system’s graphical classroom interface shall provide for the capability to select from a list of head-end sources such as VCRs, DVD players, satellite receivers, cable boxes and/or DVRs to be controlled and streamed over the networked. All devices shall have basic transport controls and other controls normally found on the IR remote of the device. The system shall allow for a preview window within the web client and once the appropriate media source as been selected, a “Send to Projector” function will send the desired media source directly to the classroom projector with a single button press. In the event a user in another classroom accesses this section of the user controls menu, any device being controlled by another classroom, the source button shall appear as orange and upon selection a pop-up shall appear informing the user the selected source is currently being used and do they still wish to view without control. This is to avoid control conflicts of shared resources. Room control of shared resources shall be automatically released upon triggering the “Release Control” button or 60 minutes of no interaction. Systems not providing source control conflict notification shall not be accepted. These controls shall be available to the teacher in the classroom via the web client or 4.3-inch touch screen interface.

J. Favorite Channels: The system’s graphical classroom interface shall have the capability to have predetermined channels represented by the broadcast channel logo or icon. The user shall have the capability to preview the video embedded within the web client. Once the user has selected an appropriate video stream, the system shall have a “Send to Projector” function allowing the teacher to send the current video stream directly to the projector with a single button press.

K. OnDemand Video: The system’s graphical classroom interface shall allow the user access to the AMX Vision2 VOD server and browse the video library. The user shall have access to title and meta-tag details. Meta-tag data including subject, grade level, duration and description along with thumbnail images for each stored video title shall also be available. The system shall allow for a preview window within the web client and once the appropriate title as been selected, a “Send to Projector” function will send desired media title directly to the classroom projector with a single button press.

L. Intercom: The system’s graphical classroom interface shall provide for 2-way communications between the classroom and the front desk or other predetermined locations such as the principal, receptionist, help desk, or librarian. Other functions shall include press-to-talk, place call, do not disturb, hang up call, and hands free.

M. Energy Management: The SYSTEM’S graphical classroom interface shall provide an interface which shall allow the teacher to override the campus wide system shutdown of classroom computers. The set override time shall be 15, 30, 60, or 120 minutes. Additional functions shall include shutdown now, hibernate, and standby.

N. Tools: The system’s graphical classroom interface shall provide a stopwatch application and countdown timer. The user shall have the capability to place a stopwatch or countdown timer pop-up on the teacher’s computer desktop for the purpose of timing students or events.

1.15 OPTIONAL MODULES (TO BE INCLUDED WITH THIS PROJECT)

A. PC Energy Management: The system’s software, with the addition of the Green Energy Management Module, shall allow for the management of any PC/Mac computers on the campus LAN. The software via the touch screen interface shall allow for the assigning of computers to specific rooms. Each computer shall be addressable by computer name or Mac address. The
system shall allow for a virtually unlimited number of combinations of rooms to be saved as named zones. Each zone can be set to a specific time to shutdown all computers in that zone for the purpose of conserving energy. The system shall provide a user-friendly interface to easily change the shutdown times or disabling the shutdown procedure temporarily for the purpose of pushing out updates. Immediately prior to the shutdown of any computer being managed a pop-up message will appear on the user’s desktop alerting the user to the shutdown thereby allowing the user time to save all documents or exit any programs. The pop-up message will also provide the user the ability to request more time thereby delaying the shutdown. When the subsequent shutdown time arrives, the same pop-up message will appear allowing for more time to be selected. If no entry is made, the computer will shut down as scheduled.

B. Video-On-Demand (VOD): The system’s software shall integrate with the Video-On-Demand Server. The user shall be able to review all available video titles and their Meta tag data information on the touch panel such as the following:

1. File type (MPEG2, MPEG4, and WMV)
2. Video description
3. Video duration
4. Grade level

C. The Resource Management Suite (RMS) is an innovative meeting room management, scheduling, and equipment monitoring software package. For end users, RMS provides access to support staff through an interactive help desk interface, ensuring that meetings, classes and other events take place without a hitch. Integrators benefit from RMS by providing remote support to system administrators

D. Classroom Manager represents a comprehensive software solution for IT staff, school administrators, educators, and students. This all-encompassing software suite delivers a simple way to monitor and maintain classrooms, auditoriums, labs and offices, and their associated electronic devices.

1. Proactively maintain equipment
2. Utilize professional help desk and monitoring
3. Schedule rooms and pre-configure equipment
4. Create instant web-based reports
5. Configure Classroom Manager to perform specific functions as a result of a pre-defined event
6. 27 reports provide IT professionals with more options and greater flexibility for tracking assets, rooms and people
7. Can support up to 1,000 classrooms and 10,000 assets

E. System is to integrate with Access Control System

1. School Administrator shall be allowed access through Apple I-Pad Remote VNC Interface

PART 2 - PRODUCTS
2.1 SYSTEM COMPONENTS

A. This system shall consist of two equipment racks. Each rack will contain equipment described as the IMS audio rack and the video rack. The IMS Audio rack shall contain the master control system in which the system software is to be installed. This rack location shall be dedicated to managing campus clocks, bells, PA/Intercom, remote microphones, telephone interfaces, background music sources, audio extractor of video sources, and common zone audio. In addition, the system shall control a secondary video rack and all classroom/flat panel equipment. The secondary rack shall contain a sub-system control unit, which shall control all video source devices to be shared over the network to the entire campus as multicast MPEG2 video streams. The following rack components shall be supplied:

1. (2) 44 RU Free Standing Equipment Cabinet: Middle Atlantic MRK-4426AXS
2. (1) 44 RU Vented Front Door for Audio Equipment Cabinet: Middle Atlantic VFD-44
3. (1) 44 RU Plexi-Glass Front Door for Video Equipment Cabinet: Middle Atlantic PFD-44
4. (2) Pair of Side Panels: Middle Atlantic SPN-44-267
5. (2) Pair of Service Tracks: Middle Atlantic Track50
6. (2) Service Track Leveler: Middle Atlantic TrackL
7. (2) Integrated 4 ½” fan top includes 3 quiet fans for Cabinet: Middle Atlantic MW-4QFT-FC
8. (2) 7 Duplex Rack Power Strip: Middle Atlantic PD-1415C
9. (2) Power Strip Mounting Bracket: Middle Atlantic PB-5A
10. (2) Round Lacing Bars, 10pc pack: Middle Atlantic LBP-2A

B. The system is based on the AMX SchoolView CampusSV® software and hardware.

C. Administration Location: Provide a password protected interactive touch panel in the administration area of the High School. The touch panel shall provide access and control to the AMX SchoolView CampusSV® software. System shall provide one wall mounted microphone and one push-to-talk microphone. There shall be a ceiling mounted speaker with an associated volume control. The software shall allow for network access and control of the administrative touch panel from anywhere on the school’s LAN or district WAN.

1. AMX NXD-1200V 12” in wall touch panel
2. AMX Back Box for selected touch panel
3. AKG 542 Gooseneck wall mount microphone
4. Shure 450 Series II push-to-talk microphone
5. lay-in tile speaker 8-ohm
6. Single gang 8-ohm volume attenuator

D. Headend Equipment:

1. (1) AMX SV - Headend
2. (1) AMX SV - Headend Third Party
3. (1) AMX Campus SV Headend Software
4. (1) AMX Additional Hardware for two-way system
5. (1) AMX SV-VOD Video On Demand System Software and Server.
6. (1) AMX RMS Server License
7. (6) AMX RMS Scheduling License
8. (6) AMX RMS Asset License
9. (1) ITEL Port TP Control Remote VNC Control Application for iPad.

E. IMS Audio Rack: Provide standard rack enclosure for all equipment listed below to reside in the Storage C200h location. Provide all shelves, rack mount kits, rack power supplies, backup power supplies, doors, rack top, lacing bars, etc as needed to have a neatly dressed rack. The required hardware shall consist of but, not be limited to, the following:

1. Barix SchoolView Annuncicom 100SV (Qty. AR)
2. Barix SchoolView Exstreamer 100SV (1 per 70volt channel)
3. Barix SchoolView Exstreamer 200SV (8-ohm) (Monitor speaker)
4. Barix equipment rack mount (1 required for every 4 Barix device)
5. AMX Netlinx Controller NI-3100
6. AMX Netlinx Processor NI-700 (1 required per 12 classrooms)
7. AMX AXB-DT MF+
8. Teac T-R680RS AM/FM tuner with AM/FM Rooftop Antenna System
9. Denon DCM-290P 5 disc CD changer
10. JK Audio AutoHybrid
11. Amino 130H network video decoder (Qty. AR)
12. USB thumb drive (Bell/Voice menu MP3 file storage) (Qty. 2)
13. Multi-channel 70volt amplifier (1 channel per specified common zone)
14. Barix SchoolView Exstreamer 100SV-CR (Qty. 1ea per 70 volt zone)
15. Lectrosonics Digital Signal Processor DM1612DSP
16. Barix SchoolView Exstreamer 200SV-CR (Touch panel audio monitor)
17. AMX PSN6.5 power supply
18. AMX AC-RK rack mount kit
19. Audio summing devices or cables as needed
20. ATS (Applied Technical Systems) CC186R rack mount clock & power supply
21. APC 1500 KVA UPS, Rack Mount

F. Video Rack: Provide standard rack enclosure for all equipment listed below to reside in the Office/Workroom B201 location. Provide all shelves, rack mount kits, rack power supplies, backup power supplies, doors, rack top, lacing bars, etc as needed to have a neatly dressed rack. The required hardware shall consist of but, not be limited to, the following:

1. (1) AMX NI-300 Netlinx Processor
2. (1) AMX PSN6.5 Power Supply
3. (1) AMX AC-RK Rack Kit
4. (8) AMX CC-NIRC IR Emitter
5. (1) APC 1500 KVA UPS, Rack Mount
6. (1) Harris P12X1VA2CPVL Panacea Lite Video Switcher
7. (1) 17” LCD Monitor, Rack Mount

G. Common Areas Audio (Hallways): Provide 70-volt speakers, which will interface to the 70-volt amplifier listed under “IMS Audio Rack”. Audio zones shall be established based on the needs of the school. Each zone shall consist of 70-volt speakers and be tapped at the wattage desired to provide the best sound for each speaker location without overloading the speaker or amplifier.

1. 2x2 Lay-in Tile, 8” 70-volt speaker: Lowell LT2-810-BB
H. Common Areas Audio (Offices): Allow for offices requiring 1-way communication or reception of bells and PA announcements by connecting to the closest 70-volt zone.

1. 2x2 Lay-in Tile, 8” 70-volt speaker: Lowell LT2-810-BB
2. 70-volt wall volume attenuator: Quam QC-10

I. Common Areas Audio (Outside): Provide 70-volt weatherized speakers to cover the desired area outside of the building(s) of the building.

2. Weatherized enclosure: Atlas 161SES White Stainless Steel

J. Classroom Areas.

1. 2 x Extron FF 120 Flat Field speakers for each classroom.

K. Remote Audio Locations: Provide integration of new stand-alone sound systems such as the following:

1. Gymnasium Sound System
2. Cafeteria Sound System
3. Music Classrooms Sound Systems
4. Wellness Center Sound System
5. Refer to Individual Local Sound Specifications for Specific Parts and Integration.

L. Classroom and Common Areas (Clocks): Digital clocks shall be provided under section 275313 integrated with the AMX SchoolView CampusSV® control system. Clock subsystem shall be RS-232 controllable.

2.2 CLASSROOM CONFIGURATION

A. The AMX SchoolView CampusSV® system

B. Classroom Hardware: AV-3 Package Provide hardware in the classroom for 2-way intercom communication. The PA audio shall be heard over the classroom AV sound system. When a PA announcement is made, local classroom audio is muted. The system shall allow for streaming video directly to the classroom projector through the local AV system. This package shall include 3 input plates for local audio/video sources and a 4.3-inch touch panel control panel. Classroom hardware shall consist of, but not be limited to, the following:

1. Required: (All quantities are 1 per classroom, unless stated otherwise.)
   a. Barix SchoolView Exstreamer 100SV
   b. Barix SchoolView Annuncicom 200SV (Replaces Exstreamer for 2-way)
   c. 1 x 2 8-ohm lay-in tile speaker (Qty. 2-4)
   d. AMX AVX-400 CAT5 presentation AV switcher with audio amplifier
   e. AMX NXD-430 (4.3-inch touch panel control).
   f. Amino Video Decoder
   g. AMX UPX-RGB+A-US (VGA w/ audio wall plate to CAT5) (Qty. 2)
   h. AMX UPX-CN+A-US (Component w/ Audio wall plate to CAT5)
i. AMX UPX HDMI with Audio Wall Plate
j. Supply HDMI cable from plate to projector
k. Premier GB-PLEN3 2 x 2 plenum box
l. FSR CDA-2 Computer Distribution Amplifier
m. AMX FG 1701-06K3 Two Way System
n. AMX SW1701-03 Classroom Software
o. AMX CB-TP5 Backbox for 4.3” Touchpanel. Furnish backbox to Division 26 contractor for installation by the Division 26 contractor.

2. Ceiling Microphone:
   a. Ceiling mounted microphone for 2-way option:
   b. Astatic WM625 Microphone

3. Display Options: Refer to Audio/Video Accessories Specification
   a. Data LCD or DLP projector
   b. LCD/Plasma display
   c. Display mount
   d. Down pipe
   e. Tile bridge ceiling kit

4. Required Cable Connects:
   a. AMX SchoolView custom cable Kit (For in wall and ceiling connections)

5. Required Interconnects: (1 Set Per classroom as needed)
   a. 3’ VGA cable (Qty. 2)
   b. VGA distribution amplifier
   c. 10’ VGA cable
   d. 10’ Video w/ audio RCA cable
   e. HDMI Cables

6. Integrated Infrared Classroom System (All Quantities are 1 System per classroom, unless stated otherwise)
   a. The LPT-F2-01 frame can handle up to two (2) Microphone/Media Interface Kits (M1), uses the six (6) input C6 advanced control unit and the R2 room module that does not have a power amplifier.

      1) (1) LPT-C6 ListenPoint Advanced Control Unit
      2) (1) LPT-R2 ListenPoint Room Module (2 M1 Max/ No Power Amp.)

   b. Additional Components to add to system:
   c. (1) M1 ListenPoint Additional Microphone with Charging Station.
   d. (1) 3.5mm TRS to Dual RCA Cable: Hosa CMR-206
   e. (1) Y-Cable to Dual RCA: Hosa YRA-104
   f. (1) Custom RCA to Male XLR Connector Cable 6’: Rapco
   g. (AR) Interconnection Cable between Control Unit and Room Module
2.3 CLASSROOM INSTALLATION (GB-PLEN3)

A. All AV package hardware shall be installed in each classroom using a 2 x 2 lay-in tile equipment enclosure. All equipment within the enclosure, when installed shall be accessible from below the ceiling. A locking removable vented door shall secure all equipment. A slotted tray shall be available to mount all equipment within the enclosure.

B. Single gang and double gang knockouts shall be available to allow for standard high and low voltage back boxes to be mounted within the enclosure.

C. The enclosure alone without the slotted tray shall be available to be installed on location during ceiling grid installation. This shall allow for AV contractors to install cable and electrical contractor to install electrical runs to the enclosure.

D. The slotted tray shall be available to the AMX SchoolView integrator to mount all CampusSV hardware offsite while the facility is still unsecured. All interconnect cables shall be connected and tested offsite. IP addresses shall be assigned and programming loaded offsite. Once the facility is secure and classroom construction is complete, the classroom equipment mounted to the slotted tray shall be installed to the equipment enclosure on-site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install per manufacturers specifications

B. **NOTE:** It shall be the Electrical Contractor’s responsibility to furnish and install all necessary conduits, raceways, standard back-boxes, pathways, and 120v power requirements to designated locations.

C. The Systems Integrator is responsible for A/V Installation including all head-end racks with associated equipment, final terminations, programming, and training. Systems Integrator will also be responsible for providing all cabling as specified. Additionally, installing all cabling (audio video and data), field devices, and speakers. All exact locations of speakers, panels, input/output jacks, etc must be field verified with the owner prior to any installation of systems.

D. Speakers on the drawings are shown in their approximate location and for quantities needed. The Contractor shall coordinate exact locations and quantities of all clock and speaker locations with the District’s Representative. Installation of all ceiling speakers shall be coordinated with these plans. In general: Corridor speakers shall be centered and spaced as per drawings. Classroom speakers shall be centered in the room or as per drawings, or centered on the wall where wall mounting is required.

3.2 WIRING

A. Size and quantity of conductors shall be in accordance with manufacturer’s requirement for cabling. Cables may be run in conduit or in return air plenums provided the cable is UL listed for Plenum use.
B. CAT6 or 18AWG stranded cabling shall be utilized for speaker, call-ins, and Executive Handsets.

C. The number of clocks on each run and the distance for the clock runs will determine secondary clock wiring.

D. Cable manufactures:
   1. 18 AWG: West Penn, Belden, or equivalent
   2. CAT6 (see Section 271500)

3.3 WARRANTY AND TRAINING

A. The system contractor shall warrant any equipment installed under this specification to be free from defects for a period of one year from the date of final acceptance.

B. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of sixteen hours training. Operators Manuals and Users Guides shall be provided at the time of this training.

C. Schedule training with Owner through the Architect, with at least seven days advance notice.

D. The system contractor shall generate a communication system directory with room numbers and associated room descriptors to be given to the school.

3.4 OCCUPANCY ADJUSTMENTS

A. When requested by the Architect within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.5 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

3.6 COMMISSIONING

A. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of sixteen hours training. Set-up in four, four-hour sessions.

B. Schedule training with Owner through the Architect, with at least seven days advance notice.

C. Occupancy Adjustments: When requested by the Architect within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, and adjusting controls to suit actual occupied conditions. Provide up to three visits to the sit for this purpose.
SECTION 27 5121 - GYMNASIUM SOUND SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of this section include raceways, electrical boxes and fittings, wiring/cabling, and control/signal amplification and transmission media, as specified in applicable Division 27 Common Work Results for Communications sections, that are used in conjunction with installation of this system.

1.2 SUMMARY

A. All cable installed in the cable tray shall have a plenum rating.

B. This Section includes the public address system for the gymnasium.

1. Microphones.
2. Preamplifiers.
3. Power Amplifiers
4. Consoles
5. Cabinets
6. Racks
7. Speakers
8. Wiring
9. Microphone Outlets
10. Volume Limiter/Compressors
11. Noise Operated Gain Controllers

1.3 SYSTEM DESCRIPTION

A. General: The Local Sound System shall be a complete system for amplifying sound signals from microphones and distributing them to loudspeakers at various locations. This system shall provide high fidelity and highly intelligible sound to all seating and surrounding areas within the venue it serves.

B. Functional Performance: Components and system features and functions shall include, but are not limited to, the following:

1. Multiple Sources: Mixing Capabilities of sources for sound amplification between microphones and inputs designated and arranged for various reproduction, playback, and recording equipment.
2. High-Quality Sound Reproduction: Freedom from noises such as pops, clicks, hiss and hum at all loudspeakers at all times during operation of the system, including standby mode with inputs off. Freedom from distortion and non-uniform coverage of amplified sound.

C. The System shall include the following:
   1. Rack mounted electronic components such as amplifiers, equalizers, etc., shall be provided in a steel cabinet with a lockable front door.
   2. Input jack plates for microphone level, line level, or telephone paging input as required.
   3. Mechanical reproductive audio devices, such as solid state, audiotape record and/or playback deck, CD player, DVD player, DAT record/playback device, etc., as required.

D. Quality Control
   1. Speakers shall be installed using standard industry techniques and hardware.
   2. Efforts shall be taken to eliminate any acoustic coupling between the building structures and the speakers.
   3. Mounting hardware shall be designed and installed with consideration of the manufacturer’s specifications.

E. Provide an assistive listening system for the hearing impaired.

F. The system shall provide intelligible reproduction in the Bleacher area from microphones shown.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of product specified, including electrical characteristics and connection requirements. This product data shall include a complete listing of wire being proposed for the installation with all the corresponding specification sheets.

C. Provide wiring diagrams detailing wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. In order to guarantee a workable system, any Distributor desiring to furnish a system shall submit the following with the shop drawings:
   1. Complete calculations, showing reverberation of the Gymnasium, in an empty condition, in a half full condition and in a full condition.
   2. Percent articulation loss of consonants (alcons) of the Gymnasium, in an empty condition, in a half full condition and in a full condition.
3. Provide a map of direct sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
4. Provide a map of reflected sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
5. Provide a map of the maximum sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
6. These calculations and maps are acceptable as run from a computer program. If they are calculated by hand, all formulas used shall be included.
7. Proposals or bids for any equipment that does not include all the above will not be considered.

1.5 RECORD DOCUMENTS

A. Provide maintenance data for materials and products, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 27 Section Common Work Results for Communications. Provide complete manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover.

B. Provide complete test reports that indicate satisfactory completion of required tests and inspections.

C. Provide complete system wiring diagrams detailing 'as built' wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: The Contractor shall retain and pay for the services of a factory-trained technical representative of the system manufacturer to supervise the installation of the system and to verify that the system has been installed and is functioning properly. The technical representative shall furnish installation drawings and technical assistance to the Installing Contractor. At the completion of the installation, the Technical Representative shall completely test the system. Documentation shall be provided to the Owner. This Contractor must have personnel on staff with current CTS Certifications. These certifications MUST be submitted with bid. This certification ensures that the installation and servicing of all aspects of the system adheres to the code of ethics of the industry standards.

B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."

C. EIA Compliance: Comply with the following Electronics Industries Association Standards:
   2. Loudspeaker, Dynamic Magnetic Structures, and Impedance, EIA-299-A.
5. Speakers for Sound Equipment, SE-103.

D. UL Compliance: Comply with requirements of UL 50. Entire system shall be UL 1459 listed.

1.7 MAINTENANCE SERVICE

A. The distributor shall provide service and maintenance of the gymnasium sound system for one year from the date of final acceptance, as part of this contract.

B. Occupancy Adjustments: When requested by the Architect within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Equipment in this Specification is based on products listed in paragraph 2.3 below and other specific manufacturers, and is intended as the standard equipment to be furnished, or as approved. All manufacturers’ published specifications pertaining to this specialization shall have the same force and effect as if shown here in full.

1. Subject to compliance with the requirements, provide a complete gymnasium sound system by the following distributors:
   a. Horizon Information
   b. Accent Communications
   c. ASCC
   d. Dobil Laboratories

B. In order to assure the Owner of all factory warranties, all equipment shall be obtained from an approved factory authorized distributor. The manufacturer and/or his authorized distributor shall show satisfactory evidence that he maintains a fully equipped factory authorized service organization, stocked with factory approved replacement parts within 75 miles of the project site and is capable of furnishing adequate inspection and service of equipment.

C. Available Manufacturers: The manufacturers and their associated catalog numbers herein specified constitute the material and desired operating features that are to be furnished. The design of this system is based upon specific components specified herein. The redesign of this system utilizing fewer components will not be acceptable and will result in the rejection of the bid and submittal.
2.2 SYSTEM REQUIREMENTS

A. General: Provide complete and fully functional public address systems using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction in accordance with published product information. Coordinate the features of materials and equipment so they form an integrated system with components and interconnections matched for optimum performance of specified functions.

2.3 EQUIPMENT AND MATERIALS

A. Main Equipment Cabinet with Rack Mounted Equipment. Quantities are shown in parentheses.

1. (1) 21 RU Equipment Cabinet with Plexi-Glass Front Door: Middle Atlantic DWR-21-17PD.
2. (1) Rack Mount Power Supply: Middle Atlantic PD-920R.
3. (1) 3RU Rack Mount Pull Out Drawer: Middle Atlantic D3.
4. (1) 3RU Rack Mount Shelf: Middle Atlantic U3.
5. (AR) Blank Panels; Middle Atlantic PBL Series.
6. (1) 2x6 Programmable Digital Sound Processor: Rane RPM26.
7. (1) Network Audio Decoder: Schoolview 100SV
8. (1) Eight Channel, Dual Output Rack Mount Mixer: Crown 28M
9. (1) 775 Watts @ 8 ohm Dual Channel Power Amplifier: QSC PLX3602
10. (1) UHF Wireless Head-worn Microphone System: Sennheiser ew152G3
   a. Include a Single Rack mount kit
   b. (1) Include a Handheld Transmitter: Sennheiser SKM100-835G3

11. (1) Single Slot Loaded CD Player with Integrated IPOD Docking Station: Tascam CD-200i

B. Additional Equipment:

1. Include with system all necessary cable end connectors i.e, XLR, ¼”, Speakon, etc.
   a. (AR) Male XLR connectors Neutrik NC3MX
   b. (AR) Female XLR connectors Neutrik NC3FX
   c. (AR) 4-Pole Speakon Connectors Neutrik NL-4FC
   d. (1) ProCo AV-1A Direct Boxes

C. ADA Hearing Assistance System.

1. System shall contain all necessary electronics and other equipment as may be required to provide a fully functional and operational system including, but not limited to the following:
   1. (1) LT-800 Stationary FM Transmitter (72, 216 or 863 MHz)
   2. (1) LA-122 Universal Antenna Kit (72 and 216 MHz)
   3. (1) LA-130 Remote Antenna Kit (863 MHz)
   4. (1) LA-326 Universal Rack Mounting Kit
5. (4) LR-500 Portable Programmable Display FM Receiver (72, 216 or 863 MHz)
6. (4) LA-164 Ear Speaker
7. (1) LA-317 4-Unit FM Product Charging/Carrying Case
8. (4) LA-362 NiMH AA Rechargeable Batteries (pkg. of 2)
9. (1) LA-304 Assistive Listening Notification Signage Kit

D. Main Speaker System

1. This loudspeaker series shall be of the two-way passive type consisting of one 15” low
frequency driver and one 1.5” high frequency driver. Performance specifications of a
typical production unit shall meet or exceed the following: frequency response,
measured with swept sine wave input, shall be flat within +/- 3dB from 41Hz – 18kHz.
Nominal dispersion, shall average 90 degrees H x 50 degrees V. Nominal impedance
shall be 8 ohms. Power handling shall be 350 watts r.m.s, and 1400 watts peak.
Sensitivity, measured with 1 watt input at 1 meter distance on axis, mean averaged over
stated bandwidth, shall be 97dB. Maximum SPL (peak) measured with music program at
stated amplifier input shall be 130dB. Dimensions: (30.8”H x 16.6”W x 19.9”D).
Weight: 25kg (55lbs).

2. The loudspeakers shall be the JBL AM5215/95. (Quantity 4).

3. Include all rigging hardware as per speaker layouts as approved by manufacturer and
other hardware required for specific installation application. All speaker hardware
including grills must be permanently mounted to the cabinet.

4. No other loudspeakers shall be acceptable unless submitted data from a separate
independent test laboratory verify that the above combined performance / size
specifications are equaled or exceeded.

E. Microphones, Cables, and Accessories

1. (2) Hand-held Microphone with On/Off Switch – Wired: Audix OM2s
2. (4) 25’ XLR Connector Microphone Cable: Rapco NJ-25.
3. (1) 10’ XLR Connector Microphone Cable: Rapco NJ-10
4. (1) Microphone Stands: Atlas-Soundolier MS-10CE

F. Wall Jacks and Panels

1. Microphone jacks shall be XLR-3F’ style mounted on a single gang plate unless
otherwise noted. All proper engravings shall be black or white letters engraved on plates
and panels as per drawings.

2. The microphone input wall jacks shall be Rapco SP1-DF. Include proper engraving as
per Drawings.

G. Wire and Cable

1. Microphone, Line Level, and Speaker Cable shall be as follows:
   a. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
   b. Speaker Cables for Main Speakers: 12 gauge, stranded, shielded, two (2)
      conductor. Cable shall be Plenum rated West Penn Wire 25227.
   c. Microphone/Line Level Cables: 22 gauge, stranded, shielded two (2) conductor.
      Cable shall be Plenum rated West Penn Wire D25454.
PART 3 - EXECUTION

3.1 INSTALLATION

A. The Systems Integrator is responsible for A/V Installation including head-end rack with associated equipment, final terminations, programming, and training. Systems Integrator will also be responsible for providing all cabling as specified. Additionally installing all cabling, field devices, and speakers. All exact locations of speakers, panels, floor boxes, input/output jacks, etc must be field verified with the owner prior to any installation of systems.

B. Install system in accordance with manufacturer's instructions.

C. Install wiring in accordance with manufacturer's recommendations.

D. Wiring Method: Install wiring in raceway except within consoles, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

E. Wiring Within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.

F. Control Circuit Wiring: Provide number of conductors as recommended by system manufacturer for control functions indicated.

G. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets, and equipment enclosures.

H. Impedance and Level Matching: Carefully match input and output impedances and signal levels at audio signal interfaces. Provide matching networks where required.

I. Provide physical isolation from each other for microphone, line-level, speaker, and power wiring. Run in separate raceways or provide 12-inch minimum separation where exposed or in same enclosure. Provide additional physical separation as recommended by equipment manufacturer.

J. Conductor Sizing: Except as otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 12 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

K. All microphone cable shall be shielded and routed in a separate raceway from loudspeaker cables.

L. Identification of Conductors and Cables: Switches, connectors, jacks, receptacles, cable and cable terminations shall be clearly, logically and permanently marked. Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

M. Line Matching Transformer Connections: Make initial connections using tap settings indicated on the Drawings.
N. Equalization: Set as flat as possible and adjust only to eliminate unwanted reflections between the speakers and the venue surfaces. Upon completion of the equalization, record the settings and permanently attach the record of these settings to the inside of the cabinet.

3.2 GROUNDING

A. Provide equipment grounding connections as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. Provide one insulated dedicated #4 AWG copper cable between the main console and the service entrance grounding electrode.

C. Ground cable shield and equipment to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.
   1. All speaker cable shielding shall be grounded at the amplifier only.

D. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.
   1. Provide 5-ohm ground at main equipment location.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new, and retest until satisfactory performance and conditions are achieved.

C. Testing: Upon completion of pretesting, notify the Architect a minimum of 10 days in advance of acceptance test performance. Schedule and conduct tests in his presence. Provide a written record of tests results.

D. Operational Test: Perform an operational system test to verify conformance of system to these Specifications. Perform tests that include originating program and page material at microphone outlets, all preamplifier program inputs, and all other inputs. Observe sound reproduction for proper volume levels and freedom from noise.

E. Power Output Test: Measure the electrical power output of each power amplifier at normal gain setting at 50, 1,000, and 12,000 Hz. The maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

F. Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of speaker line matching transformers.
G. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards. Provide a written record of all retest results.

3.4 COMMISSIONING

A. Retain and pay for the services of a competent manufacturer authorized, factory-trained technician to train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of three hours training.

B. Schedule training with Owner through the Architect with at least 7 days advance notice.

3.5 DEMONSTRATION

A. Demonstration and Training: Obtain and pay for the services of a factory-authorized service representative to demonstrate the system in all operating modes and functions and to train Owner's personnel.

B. Schedule training with Owner with at least 7 days advance notice.

C. Train Owner's personnel on procedures and schedules related to startup and shutdown, troubleshooting, service, operation, and maintenance. Provide a minimum of (2) 4 hour training sessions.

D. Training Aid: Use the approved operation and maintenance manual as an instructional aid. Refer to Division 1 Section “Contract Closeout”. Provide copies of pertinent excerpts from the manual for use in the instruction.

3.6 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

3.7 WARRANTY

A. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Owner/Engineer, or the first day of beneficial use by the Owner. A maintenance contract offering continuing factory authorized service of this system shall be made available if requested by the Owner.

END OF SECTION 27 5121
SECTION 27 5122 - CAFETERIA SOUND SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of this section include raceways, electrical boxes and fittings, wiring/cabling, and control/signal amplification and transmission media, as specified in applicable Division 27 Common Work Results for Communications sections, that are used in conjunction with installation of this system.

1.2 SUMMARY

A. All cable installed in the cable tray shall have a plenum rating.

B. This Section includes the public address system for the cafeteria.

   1. Microphones.
   2. Preamplifiers.
   3. Power Amplifiers
   4. Consoles
   5. Cabinets
   6. Racks
   7. Speakers
   8. Wiring
   9. Microphone Outlets
   10. Volume Limiter/Compressors
   11. Noise Operated Gain Controllers

1.3 SYSTEM DESCRIPTION

A. General: The Local Sound System shall be a complete system for amplifying sound signals from microphones and distributing them to loudspeakers at various locations. This system shall provide high fidelity and highly intelligible sound to all seating and surrounding areas within the venue it serves.

B. Functional Performance: Components and system features and functions shall include, but are not limited to, the following:

   1. Multiple Sources: Mixing Capabilities of sources for sound amplification between microphones and inputs designated and arranged for various reproduction, playback, and recording equipment.
2. High-Quality Sound Reproduction: Freedom from noises such as pops, clicks, hiss and hum at all loudspeakers at all times during operation of the system, including standby mode with inputs off. Freedom from distortion and non-uniform coverage of amplified sound.

C. The System shall include the following:

1. Rack mounted electronic components such as amplifiers, equalizers, etc., shall be provided in a steel cabinet with a lockable front door.
2. Input jack plates for microphone level, line level, or telephone paging input as required.
3. Mechanical reproductive audio devices, such as solid state, audiotape record and/or playback deck, CD player, DVD player, DAT record/playback device, etc., as required.

D. Quality Control

1. Speakers shall be installed using standard industry techniques and hardware.
2. Efforts shall be taken to eliminate any acoustic coupling between the building structures and the speakers.
3. Mounting hardware shall be designed and installed with consideration of the manufacturer’s specifications.

E. Provide an assistive listening system for the hearing impaired.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of product specified, including electrical characteristics and connection requirements. This product data shall include a complete listing of wire being proposed for the installation with all the corresponding specification sheets.

C. Provide wiring diagrams detailing wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. In order to guarantee a workable system, any Distributor desiring to furnish a system shall submit the following with the shop drawings:

1. Complete calculations, showing reverberation of the cafeteria, in an empty condition, in a half full condition and in a full condition.
2. Percent articulation loss of consonants (alcons) of the cafeteria, in an empty condition, in a half full condition and in a full condition.
3. Provide a map of direct sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
4. Provide a map of reflected sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
5. Provide a map of the maximum sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
6. These calculations and maps are acceptable as run from a computer program. If they are calculated by hand, all formulas used shall be included.
7. Proposals or bids for any equipment that does not include all the above will not be considered.

1.5 RECORD DOCUMENTS
A. Provide maintenance data for materials and products, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 27 Section Common Work Results for Communications. Provide complete manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover.
B. Provide complete test reports that indicate satisfactory completion of required tests and inspections.
C. Provide complete system wiring diagrams detailing 'as built' wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: The Contractor shall retain and pay for the services of a factory-trained technical representative of the system manufacturer to supervise the installation of the system and to verify that the system has been installed and is functioning properly. The technical representative shall furnish installation drawings and technical assistance to the Installing Contractor. At the completion of the installation, the Technical Representative shall completely test the system. Documentation shall be provided to the Owner. This Contractor must have personnel on staff with current CTS Certifications. These certifications MUST be submitted with bid. This certification ensures that the installation and servicing of all aspects of the system adheres to the code of ethics of the industry standards.
B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."
C. EIA Compliance: Comply with the following Electronics Industries Association Standards:
   2. Loudspeaker, Dynamic Magnetic Structures, and Impedance, EIA-299-A.
   5. Speakers for Sound Equipment, SE-103.
D. UL Compliance: Comply with requirements of UL 50. Entire system shall be UL 1459 listed.

1.7 MAINTENANCE SERVICE

A. The distributor shall provide service and maintenance of the cafeteria sound system for one year from the date of final acceptance, as part of this contract.

B. Occupancy Adjustments: When requested by the Architect within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Equipment in this Specification is based on products listed in paragraph 2.3 below and other specific manufacturers, and is intended as the standard equipment to be furnished, or as approved. All manufacturers’ published specifications pertaining to this specialization shall have the same force and effect as if shown here in full.

1. Subject to compliance with the requirements, provide a complete cafeteria sound system by the following distributors:

   a. Horizon Information
   b. Accent Communications
   c. ASCC
   d. Dobil Laboratories

B. In order to assure the Owner of all factory warranties, all equipment shall be obtained from an approved factory authorized distributor. The manufacturer and/or his authorized distributor shall show satisfactory evidence that he maintains a fully equipped factory authorized service organization, stocked with factory approved replacement parts within 75 miles of the project site and is capable of furnishing adequate inspection and service of equipment.

C. Available Manufacturers: The manufacturers and their associated catalog numbers herein specified constitute the material and desired operating features that are to be furnished. The design of this system is based upon specific components specified herein. The redesign of this system utilizing fewer components will not be acceptable and will result in the rejection of the bid and submittal.

2.2 SYSTEM REQUIREMENTS
A. General: Provide complete and fully functional public address systems using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction in accordance with published product information. Coordinate the features of materials and equipment so they form an integrated system with components and interconnections matched for optimum performance of specified functions.

2.3 EQUIPMENT AND MATERIALS

A. Main Equipment Cabinet with Rack Mounted Equipment. Quantities are shown in parentheses.

1. (1) 21 RU Equipment Cabinet with Plexi-Glass Front Door: Middle Atlantic DWR-21-17PD.
2. (1) Rack Mount Power Supply: Middle Atlantic PD-920R.
3. (1) 3RU Rack Mount Pull Out Drawer: Middle Atlantic D3.
4. (1) 3RU Rack Mount Shelf: Middle Atlantic U3.
5. (AR) Blank Panels: Middle Atlantic PBL Series.
7. (1) Network Classroom Audio/Video Decoder: Schoolview AV3
   a. To be mounted in Ceiling Pan as typical classroom as shown on drawings.
8. (1) Eight Channel, Dual Output Rack Mount Mixer: Crown 28M
9. (1) 160 Watts @ 70volt Single Channel Power Amplifier: Crown 1160A
10. (1) UHF Wireless Head-worn Microphone System: Sennheiser ew152G3
   a. Include a Single Rack mount kit
   b. (1) Include a Handheld Transmitter: Sennheiser SKM100-835G3
11. (1) Single Slot Loaded CD Player with Integrated IPOD Docking Station: Tascam CD-200i

B. Additional Equipment:

1. Include with system all necessary cable end connectors i.e, XLR, ¼’, Speakon, etc.
   a. (AR) Male XLR connectors Neutrik NC3MX
   b. (AR) Female XLR connectors Neutrik NC3FX
   c. (AR) 4-Pole Speakon Connectors Neutrik NL-4FC
   d. (1) ProCo AV-1A Direct Boxes

C. ADA Hearing Assistance System.

1. System shall contain all necessary electronics and other equipment as may be required to provide a fully functional and operational system including, but not limited to the following:
   1. (1) LT-800 Stationary FM Transmitter (72, 216 or 863 MHz)
   2. (1) LA-122 Universal Antenna Kit (72 and 216 MHz)
   3. (1) LA-130 Remote Antenna Kit (863 MHz)
4. (1) LA-326 Universal Rack Mounting Kit  
5. (4) LR-500 Portable Programmable Display FM Receiver (72, 216 or 863 MHz)  
6. (4) LA-164 Ear Speaker  
7. (1) LA-317 4-Unit FM Product Charging/Carrying Case  
8. (4) LA-362 NiMH AA Rechargeable Batteries (pkg. of 2)  
9. (1) LA-304 Assistive Listening Notification Signage Kit  

D. Main Speaker System  
1. (9) Flush mount 2-way ceiling speaker w/ 6” Driver and 70V Tap settings: Atlas Soundolier FAP62T.  
2. Include all mounting, rigging hardware per speaker layouts as approved by manufacturer and other hardware required for specific installation application.  
3. No other loudspeakers shall be acceptable unless submitted data from a separate independent test laboratory verify that the above combined performance / size specifications are equaled or exceeded.  

E. Microphones, Cables, and Accessories  
1. (2) Hand-held Microphone with On/Off Switch – Wired: Audix OM2s  
2. (4) 25’ XLR Connector Microphone Cable: Rapco NJ25.  
3. (1) 10’ XLR Connector Microphone Cable: Rapco NJ-10  
4. (1) Microphone Stands: Atlas-Soundolier MS-10CE  

F. Wall Jacks and Panels  
1. Microphone jacks shall be XLR-3F’ style mounted on a single gang plate unless otherwise noted. All proper engravings shall be black or white letters engraved on plates and panels as per drawings.  
2. The microphone input wall jacks shall be Rapco SP1-DF. Include proper engraving as per Drawings.  

G. Wire and Cable  
1. Microphone, Line Level, and Speaker Cable shall be as follows:  
   a. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.  
   b. Speaker Cables for Main Speakers: 16 gauge, stranded, shielded, two (2) conductor. Cable shall be Plenum rated West Penn Wire 25294.  
   c. Microphone/Line Level Cables: 22 gauge, stranded, shielded two (2) conductor. Cable shall be Plenum rated West Penn Wire D25454.  

PART 3 - EXECUTION  

3.1 INSTALLATION  
A. The Systems Integrator is responsible for A/V Installation including head-end rack with associated equipment, final terminations, programming, and training. Systems Integrator will also be responsible for providing all cabling as specified. Additionally installing all cabling,
field devices, and speakers. All exact locations of speakers, panels, floor boxes, input/output jacks, etc must be field verified with the owner prior to any installation of systems.

B. Install system in accordance with manufacturer's instructions.

C. Install wiring in accordance with manufacturer's recommendations.

D. Wiring Method: Install wiring in raceway except within consoles, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

E. Wiring Within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.

F. Control Circuit Wiring: Provide number of conductors as recommended by system manufacturer for control functions indicated.

G. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets, and equipment enclosures.

H. Impedance and Level Matching: Carefully match input and output impedances and signal levels at audio signal interfaces. Provide matching networks where required.

I. Provide physical isolation from each other for microphone, line-level, speaker, and power wiring. Run in separate raceways or provide 12-inch minimum separation where exposed or in same enclosure. Provide additional physical separation as recommended by equipment manufacturer.

J. Provide physical isolation from each other for microphone, line-level, speaker, and power wiring. Run in separate raceways or provide 12-inch minimum separation where exposed or in same enclosure. Provide additional physical separation as recommended by equipment manufacturer.

K. Conductor Sizing: Except as otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 12 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

L. All microphone cable shall be shielded and routed in a separate raceway from loudspeaker cables.

M. Identification of Conductors and Cables: Switches, connectors, jacks, receptacles, cable and cable terminations shall be clearly, logically and permanently marked. Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

N. Line Matching Transformer Connections: Make initial connections using tap settings indicated on the Drawings.

O. Equalization: Set as flat as possible and adjust only to eliminate unwanted reflections between the speakers and the venue surfaces. Upon completion of the equalization, record the settings and permanently attach the record of these settings to the inside of the cabinet.
3.2  GROUNDING

A. Provide equipment grounding connections as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. Provide one insulated dedicated #4 AWG copper cable between the main console and the service entrance grounding electrode.

C. Ground cable shield and equipment to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.
   1. All speaker cable shielding shall be grounded at the amplifier only.

D. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.
   1. Provide 5-ohm ground at main equipment location.

3.3  FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new, and retest until satisfactory performance and conditions are achieved.

C. Testing: Upon completion of pretesting, notify the Architect a minimum of 10 days in advance of acceptance test performance. Schedule and conduct tests in his presence. Provide a written record of tests results.

D. Operational Test: Perform an operational system test to verify conformance of system to these Specifications. Perform tests that include originating program and page material at microphone outlets, all preamplifier program inputs, and all other inputs. Observe sound reproduction for proper volume levels and freedom from noise.

E. Power Output Test: Measure the electrical power output of each power amplifier at normal gain setting at 50, 1,000, and 12,000 Hz. The maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

F. Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of speaker line matching transformers.

G. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the
Specifications and complies with applicable standards. Provide a written record of all retest results.

3.4 COMMISSIONING

A. Retain and pay for the services of a competent manufacturer authorized, factory-trained technician to train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of three hours training.

B. Schedule training with Owner through the Architect with at least 7 days advance notice.

3.5 DEMONSTRATION

A. Demonstration and Training: Obtain and pay for the services of a factory-authorized service representative to demonstrate the system in all operating modes and functions and to train Owner’s personnel.

B. Schedule training with Owner with at least 7 days advance notice.

C. Train Owner’s personnel on procedures and schedules related to startup and shutdown, troubleshooting, service, operation, and maintenance. Provide a minimum of (2) 4 hour training sessions.

D. Training Aid: Use the approved operation and maintenance manual as an instructional aid. Refer to Division 1 Section “Contract Closeout”. Provide copies of pertinent excerpts from the manual for use in the instruction.

3.6 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

3.7 WARRANTY

A. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Owner/Engineer, or the first day of beneficial use by the Owner. A maintenance contract offering continuing factory authorized service of this system shall be made available if requested by the Owner.

END OF SECTION 27 5122
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SECTION 27 5123 – LGI C204 SOUND SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of this section include raceways, electrical boxes and fittings, wiring/cabling, and control/signal amplification and transmission media, as specified in applicable Division 27 Common Work Results for Communications sections, that are used in conjunction with installation of this system.

1.2 SUMMARY

A. All cable installed in the cable tray shall have a plenum rating.

B. This Section includes the public address system for the LGI C204.

1. Microphones.
2. Preamplifiers.
3. Power Amplifiers
4. Consoles
5. Cabinets
6. Racks
7. Speakers
8. Wiring
9. Microphone Outlets
10. Volume Limiter/Compressors
11. Noise Operated Gain Controllers

1.3 SYSTEM DESCRIPTION

A. General: The Local Sound System shall be a complete system for amplifying sound signals from microphones and distributing them to loudspeakers at various locations. This system shall provide high fidelity and highly intelligible sound to all seating and surrounding areas within the venue it serves.

B. Functional Performance: Components and system features and functions shall include, but are not limited to, the following:

1. Multiple Sources: Mixing Capabilities of sources for sound amplification between microphones and inputs designated and arranged for various reproduction, playback, and recording equipment.
2. High-Quality Sound Reproduction: Freedom from noises such as pops, clicks, hiss and hum at all loudspeakers at all times during operation of the system, including standby mode with inputs off. Freedom from distortion and non-uniform coverage of amplified sound.

C. The System shall include the following:
   1. Rack mounted electronic components such as amplifiers, equalizers, etc., shall be provided in a steel cabinet with a lockable front door.
   2. Input jack plates for microphone level, line level, or telephone paging input as required.
   3. Mechanical reproductive audio devices, such as solid state, audiotape record and/or playback deck, CD player, DVD player, DAT record/playback device, etc., as required.

D. Quality Control
   1. Speakers shall be installed using standard industry techniques and hardware.
   2. Efforts shall be taken to eliminate any acoustic coupling between the building structures and the speakers.
   3. Mounting hardware shall be designed and installed with consideration of the manufacturer’s specifications.

E. Provide an assistive listening system for the hearing impaired.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of product specified, including electrical characteristics and connection requirements. This product data shall include a complete listing of wire being proposed for the installation with all the corresponding specification sheets.

C. Provide wiring diagrams detailing wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. In order to guarantee a workable system, any Distributor desiring to furnish a system shall submit the following with the shop drawings:
   1. Complete calculations, showing reverberation of the LGI C204, in an empty condition, in a half full condition and in a full condition.
   2. Percent articulation loss of consonants (alcons) of the LGI C204, in an empty condition, in a half full condition and in a full condition.
   3. Provide a map of direct sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
   4. Provide a map of reflected sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
5. Provide a map of the maximum sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
6. These calculations and maps are acceptable as run from a computer program. If they are calculated by hand, all formulas used shall be included.
7. Proposals or bids for any equipment that does not include all the above will not be considered.

1.5 RECORD DOCUMENTS

A. Provide maintenance data for materials and products, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 27 Section Common Work Results for Communications. Provide complete manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover.

B. Provide complete test reports that indicate satisfactory completion of required tests and inspections.

C. Provide complete system wiring diagrams detailing 'as built' wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: The Contractor shall retain and pay for the services of a factory-trained technical representative of the system manufacturer to supervise the installation of the system and to verify that the system has been installed and is functioning properly. The technical representative shall furnish installation drawings and technical assistance to the Installing Contractor. At the completion of the installation, the Technical Representative shall completely test the system. Documentation shall be provided to the Owner. This Contractor must have personnel on staff with current CTS Certifications. These certifications MUST be submitted with bid. This certification ensures that the installation and servicing of all aspects of the system adheres to the code of ethics of the industry standards.

B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."

C. EIA Compliance: Comply with the following Electronics Industries Association Standards:

2. Loudspeaker, Dynamic Magnetic Structures, and Impedance, EIA-299-A.
5. Speakers for Sound Equipment, SE-103.

D. UL Compliance: Comply with requirements of UL 50. Entire system shall be UL 1459 listed.
1.7 MAINTENANCE SERVICE
A. The distributor shall provide service and maintenance of the LGI C204 sound system for one year from the date of final acceptance, as part of this contract.

B. Occupancy Adjustments: When requested by the Architect within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Equipment in this Specification is based on products listed in paragraph 2.3 below and other specific manufacturers, and is intended as the standard equipment to be furnished, or as approved. All manufacturers’ published specifications pertaining to this specialization shall have the same force and effect as if shown here in full.

1. Subject to compliance with the requirements, provide a complete LGI C204 sound system by the following distributors:

   a. Horizon Information
   b. Accent Communications
   c. ASCC
   d. Dobil Laboratories

B. In order to assure the Owner of all factory warranties, all equipment shall be obtained from an approved factory authorized distributor. The manufacturer and/or his authorized distributor shall show satisfactory evidence that he maintains a fully equipped factory authorized service organization, stocked with factory approved replacement parts within 75 miles of the project site and is capable of furnishing adequate inspection and service of equipment.

C. Available Manufacturers: The manufacturers and their associated catalog numbers herein specified constitute the material and desired operating features that are to be furnished. The design of this system is based upon specific components specified herein. The redesign of this system utilizing fewer components will not be acceptable and will result in the rejection of the bid and submittal.

2.2 SYSTEM REQUIREMENTS
A. General: Provide complete and fully functional public address systems using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment
that comply with referenced standards and manufacturers' standard design and construction in accordance with published product information. Coordinate the features of materials and equipment so they form an integrated system with components and interconnections matched for optimum performance of specified functions.

2.3 EQUIPMENT AND MATERIALS

A. Main Equipment Cabinet with Rack Mounted Equipment. Quantities are shown in parentheses.

1. (1) 44 RU Free Standing Equipment Cabinet: Middle Atlantic WRK-44SA-32.
2. (1) 44 RU Vented Front Door for Equipment Cabinet: Middle Atlantic VFD-44
3. (1) Integrated 4 ½” fan top includes 3 quiet fans for Cabinet: Middle Atlantic MW4QFT-FC
4. (1) 44RU Rear Rack Rail Option: Middle Atlantic WRK-RR44
5. (1) Round Lacing Bars, 10pc pack: Middle Atlantic LBP-2A
6. (1) Rack mount sequence controller with alternate start-up mode: Lowell SCS8RK-ASM
7. (1) 12 Single Outlets, 20 Amp Vertical Power Strip: Lowell ACS-2012
8. (1) Five 20-Amp Remote Controlled Vertical Circuit Panel: Lowell RPC-420-PT
9. (1) Rack Mount Power Supply with rack light: Middle Atlantic PD-LT-815RVA
10. (1) 500pc black 10-32 phillips rack screws w/ washers: Middle Atlantic HG500
11. AR) Blank Panels; Middle Atlantic PBL Series
13. (1) Wireless Director’s intercom transmitter, Telex Model No. BTR-700-A-2, mounted in rack. Provide four belt packs, Telex Model No. TR-700, and provide four headsets, Telex Model No. PH-100
14. (1) Denon Blue Ray DVD Player with Rack Mount Kit, Model No. DBP-2012UDCIP.
15. Power Amplifiers

a. (4) 2000 Watts @ 2 ohm Dual Channel Power Amplifier: QSC PLX3602
b. (1) 400 Watts @ 4 ohm Four Channel Power Amplifier: QSC CX404

c. The Quantities of amplifiers are configured for the speakers that are specified. There shall not be any changes to these quantities of power amplifiers nor amplifier model changes. No other power amplifier shall be acceptable unless submitted data verify that the above combined performance / size specifications are equaled or exceeded.

B. Digital Audio Platform Processor/Mixer:

1. The DSP speaker processor shall provide eight balanced line inputs and eight balanced line outputs on plug-in barrier-strip connectors. Inputs and outputs shall be analog, with internal 24-bit A/D & D/A converters operating at a sample rate of 48 kHz. All internal processing shall be digital (DSP). Software shall be provided for creating/connecting DSP system components within each hardware unit. Available system components shall include (but not limited to) various forms of: mixers, equalizers, filters, crossovers, dynamics/gain controls, routers, delays, remote controls, meters, generators, and diagnostics. Ethernet communications shall be utilized for software control and configuration. After initial programming, processors may be controlled via dedicated software screens, third-party RS-232 control systems, and/or optional remote control
devices. Software shall operate on a PC computer, with network card installed, running Windows 2000/XP.

2. The 12x8 digital Audio Processor shall be the BSS Soundweb London Blu-100 (Quantity 1).
   a. Include the Eight input expansion module: BSS Blu-BIB (Quantity 1)

3. A/V Contractor Must provide factory trained personnel on staff for operation and programming of BSS digital signal processing. All proper dealerships and certifications are required for which all contactors must show that proper partnership and certifications were achieved. Additionally a BSS Manufacturers Certified Programmer and Technician must be on staff of the winning contractor. The outsourcing of an independent programmer will not be allowed. These certifications as well as personnel MUST be provided with submission of bid.

C. ADA Hearing Assistance System.

1. System shall contain all necessary electronics and other equipment as may be required to provide a fully functional and operational system including, but not limited to the following:
   1. (1) LT800 Stationary FM Transmitter (72, 216 or 863 MHz)
   2. (1) LA122 Universal Antenna Kit (72 and 216 MHz)
   3. (1) LA130 Remote Antenna Kit (863 MHz)
   4. (1) LA326 Universal Rack Mounting Kit
   5. (20) LR500 Portable Programmable Display FM Receiver (72, 216 or 863 MHz)
   6. (20) LA164 Ear Speaker
   7. (5) LA317 4-Unit FM Product Charging/Carrying Case
   8. (10) LA362 NiMH AA Rechargeable Batteries (pkg. of 2)
   9. (1) LA304 Assistive Listening Notification Signage Kit

D. Crestron Control System

1. The LGI C204 shall incorporate a Crestron Control System within the Audio/Visual System. This system shall control features of DSP Processing including microphones, audio playback as well as Video Playback, Projection, and Touch-panel Control System. The Crestron programming must integrate the Schoolview Classroom Control within the Digital Media Processor and Touch-screen operation of this system. All proper dealerships and certifications are required for which all contactors must show that proper partnership and certifications were achieved. Additionally a Crestron Manufacturers Digital Media Certified Programmer and Technician must be on local internal staff of the winning contractor. The outsourcing of an independent programmer will not be allowed. These certifications as well as personnel MUST be provided with submission of bid.

2. Provide the following Components:
   a. (1) 6x1 Digital Media Switcher: Crestron DM-MD6x1.
   b. (1) Digital Media CAT receiver and room controller: Crestron DM-RMC-100-1.
   c. (1) 5-Port Power Over Ethernet Switch: Crestron CEN-SW-POE-5.
   d. (1) Wall Mount 802.11a/b/g Wireless Access Point: Crestron CEN-WAP-ABG-1G
   e. (1) Isys 8.4” Wireless Touchpanel, Black: Crestron TPMC-8X.
f. (1) Wall Mount Docking Station for Wireless Touchscreen: Crestron TPMC-8X-DSW.
g. (1) Wall plate digital media CAT Transmitter 200: Crestron DM-TX-200-2G.
h. (2) Wall plate digital media CAT transmitter 400: Crestron DM-TX-400-3G.
i. (1) Cresnet power supply, 75 watts: Crestron CNPWS-75.
l. (AR) Crestron Certified HDMI Interface Cable 6’: Crestron CBL-HD-6.
m. (AR) Crestron Certified HDMI Interface Cable 3’: Crestron CBL-HD-3.
n. (1) Rack mount kit for CNPWS-75 power supply: Crestron CNXRMAK.
o. (1) Cresnet Distribution Block: Crestron CNTBLOCK.
q. (AR) Infrared Emitter Probe: Crestron IRP2.
r. (AR) Digital Media Cable: Crestron DM-CBL-P-SP5.
s. (AR) Cresnet Control Cable: Crestron Crestnet-NP.
t. (2) Digital Media cable connectors: Crestron DM-CONN-20.

3. No other control system shall be acceptable.

E. Rear of House Rack Mounted Equipment

1. NOTE: Equipment is to be mounted in Custom Rolltop Desk, Integrated Equipment Racks, on top riser of retractable seating.
2. (2) 20-Amp Stand-alone power module with 9’ cord and remote control contacts: Lowell RPC1-20A-CD.
3. (2) Rack Mount Power Supply with rack light: Middle Atlantic PD-LT-815RVA.
4. (1) 3RU Rack mount pull out drawer: Middle Atlantic D3.
5. (1) 2RU Rack mount pull out drawer: Middle Atlantic D2.
6. (AR) Blank Panels: Middle Atlantic PBL Series.
7. Wireless Microphone System:

a. Wireless Microphones – Wireless: Seventeen (17) wireless microphone systems shall be furnished to the Owner at the completion of the Project. At the request of the School District, Equipment and Manufacturer to be supplied MUST be as follows:

1) The Wireless Beltpack/Lavalier Microphone systems shall be the: Sennheiser ew122G3 Systems. Include all rack mount kits (Quantity 17).
   a) One Wireless System shall be mounted in main equipment cabinet and integrated into the quickset system.

2) The “Over The Ear” Lavalier Microphone shall be the Point Source CO7-SE-BE Omni-Directional microphone configured for Sennheiser Belt-pack systems. (Quantity 17).
3) The Wireless Hand-Held Transmitters shall be the: Sennheiser SKM100-835G3-A (Quantity 4).
4) The Wireless Antenna Splitter shall be the: Sennheiser G3-OMNIKIT-8. (Quantity 2) Include all rack mount kits.
5) (Quantity 1) 10’ 16-Channel XLR connector microphone snake cable for connection to mixing console from Wireless microphone rack. Manufactured by Rapco.

8. (1) Single Slot Loaded CD Player with Integrated IPOD Docking Station: Tascam CD200i.

F. 32 Channel Digital Mixing Console

1. The 32 Channel Digital Mixing Console shall be a Yamaha LS-9(32). (Quantity 1) At the request of the school district, in order to integrate with other systems within the district, no other mixing console shall be acceptable. A/V Contractor Must provide factory trained personal on staff for operation and programming of mixing console.
   a. Include the 16 Channel Digital Interface Card: Yamaha MY 16-64ES (Quantity 1)

2. (1) Sixteen Channel Digital Stage-box: Yamaha SB168-ES.
   a. To be mounted on Rear Rack Rails of Main Equipment Cabinet. Refer to Drawings for details.

G. Left/Right Main Speaker Line Array and Side-Fill Speakers with Subwoofers

1. This loudspeaker series shall be full range models of 110 Degree horizontal x 15 Degree Vertical coverage patterns, each consisting of a two-way type configuration with two 10” low/midfrequency drivers mounted in a bass reflex enclosure and one 1.4” exit throat with a 3” voice coil compression driver, and (1) model of matching low frequency module, consisting of a single 18” low frequency transducers mounted in a flyable cabinet. The full range models’ low frequency section shall contain two 10” drivers with a power handling capacity of 800 watts AES and shall have an 8Ω load. The high frequency section shall consist of one 1.4” exit throat with a 3” voice coil compression driver and horn combination with a power handling capacity of 150 watts AES and shall have a 8Ω load respectively. The combined loudspeaker system shall be capable of 130 dB SPL continuous and 133 dB SPL peak maximum output. The loudspeaker series shall have an effective operating range of 65 Hz to 18.5 kHz +/- 3 dB. Individual full range enclosures shall weigh a total of 52 lbs. and shall measure 24.84 inches wide, 12.37 inches tall and 15.64 inches in depth. The low frequency module shall contain a single 18” driver with a power handling capacity of 800 watts AES. Individual subwoofer enclosures shall weigh a total of 98 lbs. and shall measure 24.8 inches wide, 20 inches tall and 29.1 inches in depth. Each enclosure shall be made of 12-ply void-free hardwood. Each loudspeaker shall have an integrated rigging system which will allow 0°- 10° of splay per module, allowing for the formation of vertical arrays up to 6 modules deep. Electrical connections shall be made via NL4 connectors. The system shall employ Frequency Dependent Adaptive Steering™ technology to achieve a high degree of directivity, and as such shall behave as an acoustic line array when arrayed in accordance the systems design specifications, and shall exhibit only - 3dB decrease of measurable SPL per doubling of distance.

2. The line array and Side-Fill loudspeakers shall be the EAW JFL210 Line Array Module. (Quantity 10).
3. The Subwoofers shall be the EAW JFL118. (Quantity 4).
   a. Include Castor Kits for each subwoofer
4. Include all rigging hardware including all rigging pins, rigging frames and bumper bars as per cluster layouts as approved by manufacturer and what is required for specific installation application.
5. No other loudspeakers shall be acceptable.
6. Provide Speakon to Speakon connection cables, Rapco 4SP-2 for connection between Line Array Speaker cabinets. (Quantity 4).

H. Stage Monitor Speakers
1. The speakers shall be of the two-way configuration. Each loudspeaker shall have an eight ohm 12” woofer with a die-cast aluminum basket. The tweeters shall be a 1.5” Annular Polymer Diaphragm Compression drivers. Frequency response shall be from 90 Hz-20kHz with a normal program power rating of 400 watts at 8 ohms and peak level of 1600 watts at 8 ohms. The case shall be constructed of 16/18mm plywood and covered in black carpet. The loudspeaker shall have a low profile design allowing sound to be projected toward performers at a distance not less than 4 feet. Input to the system shall be two speakon 4-pole jacks. Each case shall incorporate a 16 gauge steel black grill, have recessed side bar handles, and have metal reinforcement corners.
2. The stage monitor shall be JBL MRX512M. (Quantity 4).
3. Include 30’ Speakon to Speakon connection cables, Rapco 4SP-30 (Quantity 4).

I. Microphones/Cables/Components
1. All interconnection jacks (i.e XLR, ¼”, RCA, etc.) Provided as necessary:
   a. Male XLR connectors, Neutrik NC3MX.
   b. Female XLR connectors, Neutrik NC3FX.
   c. 4-Pole Speakon Connectors Neutrik NL-4FC.
2. (3) Rapco DB-100 Direct Boxes.
3. (2) Rapco AVI-100 Audio/Video Direct Box.
5. (1) Sennheiser HD280 PRO Studio Headphones.
7. (4) Audix i-5 dynamic Instrument Microphone.
8. (2) Audix ADX51 Condenser Instrument Microphone.
9. (4) Audix MB5055 50” Carbon Fiber Boom Micro-Condenser Microphone System

J. Microphone Stands
1. Four (4) microphone stands shall be furnished to the Owner at the completion of the Project. Each stand shall extend from 33 inches to 60.5 inches, include a 10-inch diameter base that is stackable with ebony finish, and a 5/8-inch diameter with 27 threads support tube with ebony finish.
2. The Floor microphone stand shall be: Atlas/Soundolier SMS5B. (Quantity 4).
3. The short microphone stands shall be: Atlas/Soundolier DMS10E. (Quantity 4).

K. Input/Output Stage Plates and Panels

1. The Microphone Input/Output Panels shall be XLR-3F and XLR-3M style mounted on a custom black anodized panel or plate for all applications. Speakon Jacks shall be 4-Pole style mounted on designated panels and plates, as well as any additional connectors required. All proper engravings shall be white letters engraved on plates and panels.
2. Provide plates, panels, layouts and quantities as per drawings. All plates and panels are to be manufactured by Rapco.
3. Custom Stage Monitor Patch Panel (Quantity 1).
   a. Refer to drawings for layout of patch panel to be custom made and provided by sound contractor. Custom Panel shall be Manufactured by Rapco.
   b. Provide Speakon to Speakon connection cables, Rapco 4SP-2 for connection points on stage monitor patch panel. (Quantity 12).

L. Main View Video Projection System

1. (1) 10000 Lumens Large Venue Projector with Standard Lens: Sanyo PLC-HF10000L.
2. (1) Ceiling Plate: Chief – Plate Type Shall be Appropriate for Mounting Surface.
3. (1) Adjustable pipe: Chief – Pipes to be Field Verified.
4. (1) Universal RPA: Chief RPA-XX Mount for Specified Projectors.

M. Custom Presenter Podium

1. The Custom Presenter Podium and equipment rack shall be of high quality medium density ply-wood construction. All joints shall be glued, then secured with wood screws. Work surface and shelves shall be covered in Nevamar Laminate with ARP coating for scratch resistant surface. Removable reading surface, front access panel, and doors shall allow quick access to components and cabling. Rack rails shall be constructed of 11-gauge steel with 10x32-tapped rails meeting industry standards. The outer covering shall be of multiple choices of finishes. Dimensions shall be 48” W x 31D x 48” H.
2. The Custom Presenter Podium shall be manufactured by: Sound-Craft MMR48 Camberlin MMR48.
3. The following optional features shall be provided:
   b. Cable Port Outlet.
   c. Task Light
   d. Rack Mount Option
   e. Pocket Pivot Doors
   f. Keyboard Drawer
   g. Wiring Duct
   h. Castors
   i. Cable Cubby
   j. Clock/Timer
   k. Duplex Receptacle
4. Finish of desk shall be Field Verified with owner.

N. Wire and Cable

1. Microphone, Line Level, Wireless Microphone, Digital Snake, and Speaker Cable shall be as follows:
   a. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
   b. Speaker Cables for Main Speakers: 12 gauge, stranded, shielded, two (2) conductor. Cable shall be Plenum rated West Penn Wire 25227.
   c. Microphone/Line Level Cables: 22 gauge, stranded, shielded two (2) conductor. Cable shall be Plenum rated West Penn Wire D25454.
   d. Digital Snake Cable shall be Cat-5 Data cable, Plenum rated by West Penn Wire.
   e. RS232 Control Cable shall be Plenum rated by West Penn Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the Local Sound System work.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. The Systems Integrator is responsible for A/V Installation including head-end rack with associated equipment, final terminations, programming, and training. Systems Integrator will also be responsible for providing all cabling as specified. Additionally installing all cabling, field devices, and speakers. All exact locations of speakers, panels, floor boxes, input/output jacks, etc must be field verified with the owner prior to any installation of systems.

B. Install system in accordance with manufacturer's instructions.

C. Install wiring in accordance with manufacturer's recommendations.

D. Wiring Method: Install wiring in raceway except within consoles, desks, and counters. Conceal raceway and wiring except in unfinished spaces

E. Wiring Within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.

F. Control Circuit Wiring: Provide number of conductors as recommended by system manufacturer for control functions indicated.

G. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets, and equipment enclosures.
H. Impedance and Level Matching: Carefully match input and output impedances and signal levels at audio signal interfaces. Provide matching networks where required.

I. Provide physical isolation from each other for microphone, line-level, speaker, and power wiring. Run in separate raceways or provide 12-inch minimum separation where exposed or in same enclosure. Provide additional physical separation as recommended by equipment manufacturer.

J. Provide physical isolation from each other for microphone, line-level, speaker, and power wiring. Run in separate raceways or provide 12-inch minimum separation where exposed or in same enclosure. Provide additional physical separation as recommended by equipment manufacturer.

K. Conductor Sizing: Except as otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 12 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

L. All microphone cable shall be shielded and routed in a separate raceway from loudspeaker cables.

M. Identification of Conductors and Cables: Switches, connectors, jacks, receptacles, cable and cable terminations shall be clearly, logically and permanently marked. Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

N. Line Matching Transformer Connections: Make initial connections using tap settings indicated on the Drawings.

O. Equalization: Set as flat as possible and adjust only to eliminate unwanted reflections between the speakers and the venue surfaces. Upon completion of the equalization, record the settings and permanently attach the record of these settings to the inside of the cabinet.

3.3 GROUNDING

A. Provide equipment grounding connections as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. Provide one insulated dedicated #4 AWG copper cable between the main console and the service entrance grounding electrode.

C. Ground cable shield and equipment to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.

   1. All speaker cable shielding shall be grounded at the amplifier only.

D. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

   1. Provide 5-ohm ground at main equipment location.
3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new, and retest until satisfactory performance and conditions are achieved.

C. Testing: Upon completion of pretesting, notify the Architect a minimum of 10 days in advance of acceptance test performance. Schedule and conduct tests in his presence. Provide a written record of tests results.

D. Operational Test: Perform an operational system test to verify conformance of system to these Specifications. Perform tests that include originating program and page material at microphone outlets, all preamplifier program inputs, and all other inputs. Observe sound reproduction for proper volume levels and freedom from noise.

E. Power Output Test: Measure the electrical power output of each power amplifier at normal gain setting at 50, 1,000, and 12,000 Hz. The maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

F. Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of speaker line matching transformers.

G. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards. Provide a written record of all retest results.

3.5 COMMISSIONING

A. Retain and pay for the services of a competent manufacturer authorized, factory-trained technician to train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of three hours training.

B. Schedule training with Owner through the Architect with at least 7 days advance notice.

3.6 DEMONSTRATION

A. Demonstration and Training: Obtain and pay for the services of a factory-authorized service representative to demonstrate the system in all operating modes and functions and to train Owner's personnel.
B. Schedule training with Owner with at least 7 days advance notice.

C. Train Owner’s personnel on procedures and schedules related to startup and shutdown, troubleshooting, service, operation, and maintenance. Provide a minimum of (2) 4 hour training sessions.

D. Training Aid: Use the approved operation and maintenance manual as an instructional aid. Refer to Division 1 Section “Contract Closeout”. Provide copies of pertinent excerpts from the manual for use in the instruction.

3.7 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

3.8 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, adjusting controls, and investigating possible need for any system revisions required to meet actual occupancy conditions. Provide up to 3 visits to the site for this purpose.

3.9 WARRANTY

A. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Owner/Engineer, or the first day of beneficial use by the Owner. A maintenance contract offering continuing factory authorized service of this system shall be made available if requested by the Owner.

END OF SECTION 27 5123
SECTION 27 5124 - BAND/ORCHESTRA/CHORAL SOUND SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of this section include raceways, electrical boxes and fittings, wiring/cabling, and control/signal amplification and transmission media, as specified in applicable Division 27 Common Work Results for Communications sections, that are used in conjunction with installation of this system.

1.2 SUMMARY

A. All cable installed in the cable tray shall have a plenum rating.

B. This Section includes the public address system for the cafeteria.

1. Microphones.
2. Preamplifiers.
3. Power Amplifiers
4. Consoles
5. Cabinets
6. Racks
7. Speakers
8. Wiring
9. Microphone Outlets
10. Volume Limiter/Compressors
11. Noise Operated Gain Controllers

1.3 SYSTEM DESCRIPTION

A. General: The Local Sound System shall be a complete system for amplifying sound signals from microphones and distributing them to loudspeakers at various locations. This system shall provide high fidelity and highly intelligible sound to all seating and surrounding areas within the venue it serves.

B. Functional Performance: Components and system features and functions shall include, but are not limited to, the following:

1. Multiple Sources: Mixing Capabilities of sources for sound amplification between microphones and inputs designated and arranged for various reproduction, playback, and recording equipment.
2. High-Quality Sound Reproduction: Freedom from noises such as pops, clicks, hiss and hum at all loudspeakers at all times during operation of the system, including standby mode with inputs off. Freedom from distortion and non-uniform coverage of amplified sound.

C. The System shall include the following:

1. Rack mounted electronic components such as amplifiers, equalizers, etc., shall be provided in a steel cabinet with a lockable front door.
2. Input jack plates for microphone level, line level, or telephone paging input as required.
3. Mechanical reproductive audio devices, such as solid state, audiotape record and/or playback deck, CD player, DVD player, DAT record/playback device, etc., as required.

D. Quality Control

1. Speakers shall be installed using standard industry techniques and hardware.
2. Efforts shall be taken to eliminate any acoustic coupling between the building structures and the speakers.
3. Mounting hardware shall be designed and installed with consideration of the manufacturer’s specifications.

E. Provide an assistive listening system for the hearing impaired.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of product specified, including electrical characteristics and connection requirements. This product data shall include a complete listing of wire being proposed for the installation with all the corresponding specification sheets.

C. Provide wiring diagrams detailing wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. In order to guarantee a workable system, any Distributor desiring to furnish a system shall submit the following with the shop drawings:

1. Complete calculations, showing reverberation of the cafeteria, in an empty condition, in a half-full condition and in a full condition.
2. Percent articulation loss of consonants (alcons) of the cafeteria, in an empty condition, in a half-full condition and in a full condition.
3. Provide a map of direct sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
4. Provide a map of reflected sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
5. Provide a map of the maximum sound pressure levels for the entire seating area and indicate the speaker input power for the given sound pressure levels.
6. These calculations and maps are acceptable as run from a computer program. If they are calculated by hand, all formulas used shall be included.
7. Proposals or bids for any equipment that does not include all the above will not be considered.

1.5 RECORD DOCUMENTS

A. Provide maintenance data for materials and products, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 27 Section Common Work Results for Communications. Provide complete manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover.

B. Provide complete test reports that indicate satisfactory completion of required tests and inspections.

C. Provide complete system wiring diagrams detailing 'as built' wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: The Contractor shall retain and pay for the services of a factory-trained technical representative of the system manufacturer to supervise the installation of the system and to verify that the system has been installed and is functioning properly. The technical representative shall furnish installation drawings and technical assistance to the Installing Contractor. At the completion of the installation, the Technical Representative shall completely test the system. Documentation shall be provided to the Owner. This Contractor must have personnel on staff with current CTS Certifications. These certifications MUST be submitted with bid. This certification ensures that the installation and servicing of all aspects of the system adheres to the code of ethics of the industry standards.

B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."

C. EIA Compliance: Comply with the following Electronics Industries Association Standards:

2. Loudspeaker, Dynamic Magnetic Structures, and Impedance, EIA-299-A.
5. Speakers for Sound Equipment, SE-103.
D. UL Compliance: Comply with requirements of UL 50. Entire system shall be UL 1459 listed.

1.7 MAINTENANCE SERVICE

A. The distributor shall provide service and maintenance of the band/orchestra/choral sound systems for one year from the date of final acceptance, as part of this contract.

B. Occupancy Adjustments: When requested by the Architect within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Equipment in this Specification is based on products listed in paragraph 2.3 below and other specific manufacturers, and is intended as the standard equipment to be furnished, or as approved. All manufacturers’ published specifications pertaining to this specialization shall have the same force and effect as if shown here in full.

1. Subject to compliance with the requirements, provide a complete band/orchestra/choral sound systems by the following distributors:
   a. Horizon Information
   b. Accent Communications
   c. ASCC
   d. Dobil Laboratories

B. In order to assure the Owner of all factory warranties, all equipment shall be obtained from an approved factory authorized distributor. The manufacturer and/or his authorized distributor shall show satisfactory evidence that he maintains a fully equipped factory authorized service organization, stocked with factory approved replacement parts within 75 miles of the project site and is capable of furnishing adequate inspection and service of equipment.

C. Available Manufacturers: The manufacturers and their associated catalog numbers herein specified constitute the material and desired operating features that are to be furnished. The design of this system is based upon specific components specified herein. The redesign of this system utilizing fewer components will not be acceptable and will result in the rejection of the bid and submittal.
2.2 SYSTEM REQUIREMENTS

A. General: Provide complete and fully functional public address systems using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction in accordance with published product information. Coordinate the features of materials and equipment so they form an integrated system with components and interconnections matched for optimum performance of specified functions.

2.3 EQUIPMENT AND MATERIALS

A. Rehearsal Resource Center With Integrated Equipment Racks

1. The custom resource center with integrated equipment rack shall be constructed of, the top being 1/8” thick thermo-fused composite ply-wood construction with polyester laminate finish in graphite. The side and interior panels constructed of ¾” industrial grade particleboard in polyester laminate finish in optional colors. Rack rails shall be constructed of 11-gauge steel with 10x32-tapped rails meeting industry standards. Refer to drawings for design and equipment racking locations.

2. The Rehearsal Resource Center shall be manufactured by Wenger Corp, Model: “The Rehearsal Resource Center – Twin Set” with Castors and Stereo Rack Option (121C003) (Quantity 3). Finish of center shall be Field Verified with architect and owner.

B. Main Equipment Rack Mounted Equipment. Quantities are shown in parentheses.

1. (AR) Blank Panels: Middle Atlantic PBL Series.
2. (3) Programmable Digital Sound Processor: QSC DSP3.
3. (4) Network Classroom Audio/Video Decoder: Schoolview AV3
   a. To be mounted in Ceiling Pan as typical classroom as shown on drawings.
   b. Note: Quantity of (2) systems to be installed in Classroom C206
4. (3) 330 Watts @ 8 ohm Dual Channel Power Amplifier: QSC GX5
5. (3) Single Slot Loaded CDRW with Hard Disk Recorder: Tascam SS-CDR1
6. (1) UHF Wireless Head-worn Microphone System: Sennheiser ew152G3
   a. Include a Single Rack mount kit
7. (3) Single Slot Loaded CD Player with Integrated IPOD Docking Station: Tascam CD-200i
8. 16 Channel Mixing Console
   a. (3) Performance and Recording Mixing Console: PreSonus StudioLive 16.4.2.
   b. No other mixing console shall be acceptable unless submitted data verify that the above combined performance / size specifications are equaled or exceeded

C. Additional Equipment:
1. Include with system all necessary cable end connectors i.e, XLR, ¼', Speakon, etc.
   a. (AR) Male XLR connectors Neutrik NC3MX
   b. (AR) Female XLR connectors Neutrik NC3FX
   c. (AR) 4-Pole Speakon Connectors Neutrik NL-4FC
   d. (1) ProCo DB-1A Direct Boxes

D. ADA Hearing Assistance System.

1. System shall contain all necessary electronics and other equipment as may be required to provide a fully functional and operational system including, but not limited to the following. Provide a total of (3) systems each consisting of the following:
   1. (1) LT-800 Stationary FM Transmitter (72, 216 or 863 MHz)
   2. (1) LA-122 Universal Antenna Kit (72 and 216 MHz)
   3. (1) LA-130 Remote Antenna Kit (863 MHz)
   4. (1) LA-326 Universal Rack Mounting Kit
   5. (4) LR-500 Portable Programmable Display FM Receiver (72, 216 or 863 MHz)
   6. (4) LA-164 Ear Speaker
   7. (1) LA-317 4-Unit FM Product Charging/Carrying Case
   8. (4) LA-362 NiMH AA Rechargeable Batteries (pkg. of 2)
   9. (1) LA-304 Assistive Listening Notification Signage Kit

E. Main Speaker System

1. The loudspeaker shall consist of a 250 mm (10 in) low frequency transducer, a coaxial 125 mm (5 in) mid frequency transducer with a 25 mm (1 in) compression driver, and frequency dividing network. The low frequency driver’s voice coil shall be 50 mm (2 in) in diameter and the mid frequency driver’s voice coil shall be 25 mm (1 in) in diameter. Performance specifications of a typical unit shall be as follows: Usable frequency response shall extend from 38 Hz to 17 kHz (10 dB below rated sensitivity, half-space, no external equalization). Rated power shall be at least 500 watts continuous program power for 100 continuous hours duration (defined as 3 dB above a test signal of filtered random pink noise conforming to IEC268-5). Measured sensitivity shall be at least 93 dB-SPL (at 1m [3.3 ft] with 2.83V input, avg. 100 Hz to 10 kHz). The input shall be switchable for use either at nominal 4 ohms, or on a 70.7V or 100V distributed speaker line via built-in transformer. Selectable taps shall nominally be 150W, 75W, or 38W on a 70.7V or 100V distributed line, plus 19W on 70.7V line only. The system shall be protected against damage from occasional overpowering via full range limiting, which shall be inaudible during activation. The coaxial mid-high driver shall be horn loaded to cover 120 degrees horizontal by 110 degrees vertical with a high degree of accuracy. The cabinet shall be molded High Impact PolyStyrene (HIPS) with ten percent glass fill, and a 5 mm internal foamed polyurethane secondary mold. The grille shall be backed by multi-layer foam and be secured via screws to keep it in place when facing downward. The cabinet and grille shall be paintable. The low frequency transducer shall have a neodymium magnet, a cone of woven fiberglass and Kevlar® and butyl rubber surround, with the frame protected from direct weather exposure. The mid frequency transducer element of the coaxial mid-high driver shall have an anodized aluminum cone with an EPDM rubber (a Terpolymer of Ethylene and Propylene) surround, with the frame protected from direct weather exposure. The compression driver shall be constructed with a titanium diaphragm for weather resistance. The coaxial mid-high driver shall be
protected with a secondary acoustically transparent screen. The system shall withstand Mil Spec 810 testing with specified durations with no effect on its acoustical performance or structural integrity; salt spray (method 509.3), temperature (method 501.3 and 502.3), humidity (method 507.3) and ultraviolet (method 505.3). Further, it shall pass Mil-Std-202F (method 101D) for salt spray. They system shall have an IEC 529 splashproof rating of IP-X5. For theft deterrence, the installation access area shall be hidden behind a snap-out cover on the front grille. The included ball mechanism shall be internal to the cabinet. The cabinet shall have ten (10) 6 mm mounting points including 3 on each side and 3 on top and bottom and an accessory U-bracket shall be available. The grille logo shall be rotatable for proper orientation with loudspeaker mounted horizontally or vertically. The external wiring connectors shall be screw-down terminals. Overall cabinet dimensions shall be no greater than 593 high x 372 mm wide x 345 mm deep (23.3 x 14.6 x 13.5 in) and shall weigh no more than 18.9 kg (42 lb). The finish shall be lightly textured black or white.

2. The loudspeakers shall be the JBL Control 30 with included Invisiball mounting system. (Quantity 6).

   a. Note: Speakers in Choral C206 shall include the Ceiling Mount Invisiball mounting system.

3. Include all mounting hardware as per speaker layouts as approved by manufacturer and other hardware required for specific installation application.

4. No other loudspeakers shall be acceptable unless submitted data from a separate independent test laboratory verify that the above combined performance / size specifications are equaled or exceeded.

F. Microphones, Cables, and Accessories

1. (6) Hand-held Microphone with On/Off Switch – Wired: Audix OM2s
2. (12) Instrument Microphone- Wired: Audix i5
3. (12) Recording/Hanging Microphone - Wired: Shure SM94
5. (12) 10’ XLR Connector Microphone Cable: Rapco NJ-10
6. (6) 3’ XLR Connector Microphone Cable: Rapco NJ-3

G. Wall Jacks and Panels

1. Microphone jacks shall be XLR-3F’ style mounted on a single gang plate unless otherwise noted. All proper engravings shall be black or white letters engraved on plates and panels as per drawings.
2. The microphone input wall jacks shall be Rapco SP1-DF. Include proper engraving as per Drawings.
3. The rooms C205, C206, and C207 Custom microphone input/output rack panels as well as floor pocket plates shall be manufactured by Rapco. Refer to drawings for jack input/output layouts. Include Proper Engravings as per drawings.

H. Wire and Cable

1. Microphone, Line Level, and Speaker Cable shall be as follows:
a. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
b. Speaker Cables for Main Speakers: 12 gauge, stranded, shielded, two (2) conductor. Cable shall be Plenum rated West Penn Wire 25227.
c. Microphone/Line Level Cables: 22 gauge, stranded, shielded two (2) conductor. Cable shall be Plenum rated West Penn Wire D25454.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Systems Integrator is responsible for A/V Installation including head-end rack with associated equipment, final terminations, programming, and training. Systems Integrator will also be responsible for providing all cabling as specified. Additionally installing all cabling, field devices, and speakers. All exact locations of speakers, panels, floor boxes, input/output jacks, etc must be field verified with the owner prior to any installation of systems.

B. Install system in accordance with manufacturer's instructions.

C. Install wiring in accordance with manufacturer's recommendations.

D. Wiring Method: Install wiring in raceway except within consoles, desks, and counters. Conceal raceway and wiring except in unfinished spaces

E. Wiring Within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.

F. Control Circuit Wiring: Provide number of conductors as recommended by system manufacturer for control functions indicated.

G. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets, and equipment enclosures.

H. Impedance and Level Matching: Carefully match input and output impedances and signal levels at audio signal interfaces. Provide matching networks where required.

I. Provide physical isolation from each other for microphone, line-level, speaker, and power wiring. Run in separate raceways or provide 12-inch minimum separation where exposed or in same enclosure. Provide additional physical separation as recommended by equipment manufacturer.

J. Provide physical isolation from each other for microphone, line-level, speaker, and power wiring. Run in separate raceways or provide 12-inch minimum separation where exposed or in same enclosure. Provide additional physical separation as recommended by equipment manufacturer.

K. Conductor Sizing: Except as otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 12 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
L. All microphone cable shall be shielded and routed in a separate raceway from loudspeaker cables.

M. Identification of Conductors and Cables: Switches, connectors, jacks, receptacles, cable and cable terminations shall be clearly, logically and permanently marked. Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

N. Line Matching Transformer Connections: Make initial connections using tap settings indicated on the Drawings.

O. Equalization: Set as flat as possible and adjust only to eliminate unwanted reflections between the speakers and the venue surfaces. Upon completion of the equalization, record the settings and permanently attach the record of these settings to the inside of the cabinet.

3.2 GROUNDING

A. Provide equipment grounding connections as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. Provide one insulated dedicated #4 AWG copper cable between the main console and the service entrance grounding electrode.

C. Ground cable shield and equipment to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.

   1. All speaker cable shielding shall be grounded at the amplifier only.

D. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

   1. Provide 5-ohm ground at main equipment location.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new, and retest until satisfactory performance and conditions are achieved.

C. Testing: Upon completion of pretesting, notify the Architect a minimum of 10 days in advance of acceptance test performance. Schedule and conduct tests in his presence. Provide a written record of tests results.
D. Operational Test: Perform an operational system test to verify conformance of system to these Specifications. Perform tests that include originating program and page material at microphone outlets, all preamplifier program inputs, and all other inputs. Observe sound reproduction for proper volume levels and freedom from noise.

E. Power Output Test: Measure the electrical power output of each power amplifier at normal gain setting at 50, 1,000, and 12,000 Hz. The maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

F. Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of speaker line matching transformers.

G. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards. Provide a written record of all retest results.

3.4 COMMISSIONING

A. Retain and pay for the services of a competent manufacturer authorized, factory-trained technician to train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of three hours training.

B. Schedule training with Owner through the Architect with at least 7 days advance notice.

3.5 DEMONSTRATION

A. Demonstration and Training: Obtain and pay for the services of a factory-authorized service representative to demonstrate the system in all operating modes and functions and to train Owner’s personnel.

B. Schedule training with Owner with at least 7 days advance notice.

C. Train Owner’s personnel on procedures and schedules related to startup and shutdown, troubleshooting, service, operation, and maintenance. Provide a minimum of (2) 4 hour training sessions.

D. Training Aid: Use the approved operation and maintenance manual as an instructional aid. Refer to Division 1 Section “Contract Closeout”. Provide copies of pertinent excerpts from the manual for use in the instruction.

3.6 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.
3.7 WARRANTY

A. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Owner/Engineer, or the first day of beneficial use by the Owner. A maintenance contract offering continuing factory authorized service of this system shall be made available if requested by the Owner.

END OF SECTION 27 5124
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SECTIOIN 27 5313 - GPS CLOCK SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of Contract, including General and Supplementary Conditions
      and Division-1 Specification sections, apply to work of this section.
   B. Division 27 Common Work Results for Communications sections apply to work specified in
      this section.

1.2 DEFINITIONS
   A. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an
      integrated network to determine geographic location anywhere in the world, and which employs
      and transmits atomic time, the most accurate and reliable time.

1.3 SYSTEM DESCRIPTION
   A. GPS wireless clock system shall continually synchronize clocks throughout the facility, and
      shall be capable of clock readouts in multiple time zones where desired.
   B. The system shall synchronize all clocks to each other. The system shall utilize GPS technology
      to provide atomic time. The system shall not require hard wiring. Clocks shall automatically
      adjust for Daylight Savings Time.
   C. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day, and the system
      shall have an internal oscillator that maintains plus or minus one second per day between
      synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
   D. The system shall include an internal clock reference so that failure of the GPS signal shall not
      cause the clocks to fail in indicating time.
   E. The system shall incorporate a “fail-safe” design so that failure of any component shall not
      cause failure of the system. Upon restoration of power or repair of failed component, the system
      shall resume normal operation without the need to reset the system or any component thereof.
   F. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being
      relocated at any time.

1.4 REGULATORY REQUIREMENTS
   A. Equipment and components furnished shall be of manufacturer’s latest model.
B. Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:

1. This device may not cause harmful interference
2. This device must accept interference received, including interference that may cause undesired operation.
3. Transmitter frequency shall be governed by FCC Part 90.35.
4. Transmitter output power shall be governed by FCC Part 90.257(b).

C. System shall be installed in compliance with local and state authorities having jurisdiction.

1.5 SUBMITTALS

A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.

B. Operating License: Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.

C. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.

D. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.

1.6 SUBSTITUTIONS

A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.

B. Proposed substitutions shall be identified not less than 10 days prior to bid date. Any approved substitution will be issued via Addendum.

C. Other systems requiring wiring and/or conduit between master and clocks, or which require connection of clocks to external electrical power supply will not be acceptable.

1.7 QUALITY ASSURANCE

A. Permits: Obtain operating license for the transmitter from the FCC.

B. Qualifications:

1. Manufacturer: Company specializing in manufacturing commercial time systems with a minimum of 10 continuous years of documented experience.
2. Installer: Company with documented experience in the installation of commercial time systems.
1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.

B. Store equipment in finished building, unopened containers until ready for installation.

1.9 PROJECT SITE CONDITIONS

A. Clocks shall not be installed until painting and other finish work in each room is complete.

B. Coordinate installation of GPS receiver for access to the roof or exterior side wall so that the bracket and related fasteners are watertight.

1.10 SYSTEM STARTUP

A. At completion of installation and prior to final acceptance, turn on the equipment to ensure that all equipment is operating properly, and that all clocks are functioning.

PART 2 - PRODUCTS

2.1 MANUFACTURER


B. Clock systems that utilize a repeater type signal with external antennas shall not be permitted. This shall include the wireless clock systems represented by Sapling, Inc. or the Bogen clock system that is private labeled by Sapling, Inc.

2.2 SEQUENCE OF OPERATION

A. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version, then it checks the position of the switches and stores their position in memory. The transmitter then looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.

B. Analog Clock Operation:

1. When clock is plugged into power supply: A) Press the red button when the red second hand is at the 12:00 position. At this time the microprocessor will lock in the location of the second hand. B) After the red second hand has passed over the minute hand (first second hash mark after minute hand), press, and release the red button. At this time the
microprocessor will lock in the location of the minute hand. The microprocessor then assumes the location of the hour hand.

2. After the red button has been pressed twice, the micro processor will start searching the channels. It will start at channel No. 1 and proceed one by one until it either decodes a valid signal or reaches channel No. 16. If no signal is detected the receiver will be shut off and will try again later. If a signal is received, the micro processor will store the channel number, set the clock to the receive the time. For the next minute the clock will beep every time that it receives a valid time signal. If the clock is in a good signal area it will beep once a second. If the clock beeps every few seconds, the clock is in a marginal signal area. Analog clocks can operate in marginal signal areas, but battery life will be about 25 percent shorter.

3. After initial set, the clock will shut off the receiver. On a pre-scheduled basis, the microprocessor will turn the receiver back on and starting with the stored channel, it will again look for a valid time signal. However, the beeper will not operate.

4. If the clock has not decoded a valid time signal for seven days, then it will go back to a double-step mode.

2.3 EQUIPMENT

A. General: The clock system shall include a transmitter, a roof or window mounted GPS receiver, indicating clocks, and all accessories for complete operation.

B. Transmitter (quantity as required to provide complete coverage of building): Primex Wireless Model FM-72, consisting of wireless transmitter with GPS receiver. Unit shall obtain current atomic time from satellite. The clock system shall transmit time continuously to all clocks in the system.

1. Transmission:
   a. Frequency Range: 72.100 to 72.400 MHz.
   b. Transmission Range: one mile, open field.
   c. Radio technology: narrowband FM
   d. Number of channels: 16
   e. Channel bandwidth: 20 kHz maximum
   f. Transition mode: one-way communication
   g. Data rate: 2 KBps
   h. Operating range: 0 degrees C. to 70 degrees C.

2. Transmitter:
   a. Transmitter output power: +26 to +30 dBm
   b. Frequency deviation: +/- 4 kHz
   c. Transmitter power requirements: 120 VAC 60 Hz
   d. Internal power requirements: 5 VDC
   e. Carrier frequency stability: +/- 20 ppm

3. Transmitter shall have 16 selectable channels to assure interference-free reception.
4. Transmitter shall have the following switches:
   a. Time zone adjustment switches for all time zones in the world. Includes all US 
      time zones: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.
   b. Daylight Saving Time bypass switch.
   c. 12-hour or 24-hour display.

5. Transmitter housing shall be black metal case, 16-3/4 inches by 12 inches by 1-7/8 inches 
   in size.
6. Antenna shall be 46 inches high, commercial type, mounted on top center of transmitter 
   housing. Antenna gain shall be < 2.2 dB. Antenna polarization shall be vertical.
7. Transmitter housing shall incorporate a display which shall include the following:
   a. Time readout
   b. AM and PM indicator if 12-hour time display is set
   c. Day and date readout
   d. Indicator for daylight savings or standard time
   e. LED which shall flash red in event of reception problem
   f. GPS reception indicator

8. Transmitter shall contain an internal clock such that failure of reception from the GPS 
   will not disable the operation of the clocks.

C. Power supply:
   1. Model Number: 140003
   2. Input: 120 volt AC 50/60 Hz, 0.4 amp.
   3. Output: 9 volt DC, 1.5 amp.

D. GPS Receiver: Model Number Q11695, GPS roof mounted, with 200 foot cable attached.
   1. The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof 
      case, 3-7/8 inches by 4-3/16 inches by 2 inches, designed for roof or outdoor mounting. 
      Provide mounting bracket for attachment to roof structure.

E. Type T1 - 12 ½” diameter, traditional analog clock with black polycarbonate frame and clear 
   polycarbonate lens. Face shall be white. Hour and minute hands shall be black. Analog clocks 
   shall be provided with red sweep second hand

   1. Clocks shall have 120V operation.
   2. Clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off 
      switch located on the transmitter shall disable this function if desired.
   3. Time shall be automatically updated from the transmitter 6 times per day.
   4. 12-1/2 inch analog clock lock: Tamper-proof/theft resistant hangers and slots in the 
      backs of the analog clocks.
   5. Clock receivers shall be as follows:
      a. Receiver sensitivity: >-110 dBm
      b. Receiver power: 120V AC
      c. Antenna type: internal
      d. Antenna gain: -7 dBd
6. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
7. Clocks shall be flush mounted.
8. Primex Model No. 14306. Quantity as shown on drawings.

F. Type T2 - 2.5”, 6 digit display, digital clock with red LED display.

1. Clocks shall have 120V operation.
2. Clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.
3. Time shall be automatically updated from the transmitter 6 times per day.
4. Clock receivers shall be as follows:
   a. Receiver sensitivity: >-110 dBm
   b. Receiver power: 120V AC
   c. Antenna type: internal
   d. Antenna gain: -7 dBi

5. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
6. Clocks shall be flush mounted.
7. Primex Model No. XRA1B200 (Quantity as shown on drawings)

G. Type T3 - 16” diameter, traditional analog clock with black polycarbonate frame and clear polycarbonate lens. Face shall be white. Hour and minute hands shall be black. Analog clocks shall be provided with red sweep second hand.

1. Clocks shall have 120V operation.
2. Clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.
3. Provide a wireguard for the type T3 clocks located in the Gymnasium.
4. Time shall be automatically updated from the transmitter 6 times per day.
5. 16 inch analog clock lock: Tamper-proof/theft resistant hangers and slots in the backs of the analog clocks.
6. Clock receivers shall be as follows:
   a. Receiver sensitivity: >-110 dBm
   b. Receiver power: 120V AC
   c. Antenna type: internal
   d. Antenna gain: -7 dBi

7. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
8. Clocks shall be surface mounted and dual-sided.
9. Primex Model No. 14339. Quantity as shown on drawings

H. Type T4 and T5 - 4”, 4 digit display, digital clock with red LED display, single and dual-sided.

1. Clocks shall have 120V operation.
2. Clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.
3. Time shall be automatically updated from the transmitter 6 times per day.
4. Clock receivers shall be as follows:
   a. Receiver sensitivity: >-110 dBm
   b. Receiver power: 120V AC
   c. Antenna type: internal
   d. Antenna gain: -7 dBi
5. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
6. Clocks shall be surface mounted and dual-sided
7. Single-side, Primex Model No. XRA1B201 and double-side ceiling mount, Primex Model No. XRA1B424 – Quantity as shown on drawings.

I. Wire guards: Provide one for each analog clock, where noted on drawings as follows:
   1. Model No. 14123, 18 by 18 inch size, for 16 inch diameter analog clocks.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
   B. Verify that 120 volt electrical outlet is located within 6 feet of location of transmitter, and that outlet is operational and properly grounded.

3.2 INSTALLATION
   A. GPS Unit: Install on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves or debris. Seal cable connection to GPS with cable connection sealant. Any added cable lengths must be protected from outside elements.
   B. Transmitter:
      1. Locate transmitter where indicated, a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls. The preferred transmitter location for best transmission coverage is centrally located on the top floor of the building.
      2. Attach receiver to transmitter using cable.
      3. Connect antenna to transmitter, using care not to strip threads.
      4. Connect power supply to the transmitter.
      5. Set the channel number on the display to correspond to the FCC license.
      6. Plug power supply into electrical outlet.
C. Analog clocks: Perform the following operations with each clock:
   1. Plug clock into wall outlet.
   2. Set clock to correct time in accordance with manufacturer's instructions.
   3. Observe analog clock until valid signals are received and analog clock adjusts itself to correct time.
   4. Install the analog clock on the wall in the indicated location, plumb, level and tight against wall. If using 12-1/5 inch clock, attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.

3.3 ADJUSTING
   A. Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

3.4 CLEANING
   A. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.5 DEMONSTRATION
   A. Provide training to Owner's representative on setting and adjusting clocks, replacing batteries and routine maintenance.

3.6 PROTECTION
   A. Protect finished installation until final acceptance of the project.
SECTION 28 0100 - BASIC ELECTRONIC SAFETY AND SECURITY SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 28.

B. This section is a Division 28 Electronic Safety and Security Systems section, and is a part of each Division 28 Section.

C. Requirements of the following Division 28 Sections apply to this section:

D. Division 28 section 28 0500 “Common Work results for Electronic Safety and Security”.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01 - reference individual sections for further expansion of these requirements:

1. Abbreviations and Definitions
2. Permits, Codes, and Inspections
3. Visiting Premises
4. Submittals
5. Project Drawings and Specifications
6. Cooperation and Coordination with Other Trades
7. Product Listing
8. Nameplate Data
9. Record Documents
10. Maintenance Manuals
11. Warranty
12. Delivery, Storage, and Handling
13. Sequence of Work
14. Electrical Installations
15. Cleaning
16. Testing
17. Instructions to the Owner

1.3 ABBREVIATIONS

A. General: Utilize the following abbreviations and definitions for discernment within the Drawings and Specifications.
1. Abbreviations:

   a. ANSI  American National Standards Institute
   b. ASA   American Standards Association
   c. ASTM  American Society of Testing Materials
   d. BICSI Building Industry Consulting Services International
   e. CBM   Certified Ballast Manufacturers
   f. EC    Electrical Contractor
   g. EIA   Electronic Industries Association
   h. ETL   Electrical Testing Laboratories, Inc.
   i. GC    General Contractor
   j. HVAC  Heating, Ventilating, Air Conditioning Contractor
   k. ICEA  International Cable Engineers Association
   l. IEEE  Institute of Electrical and Electronics Engineers
   m. MC    Mechanical Contractor
   n. NEC   National Electrical Code
   o. NEMA  National Electrical Manufacturers Association
   p. NFPA  National Fire Protection Association
   q. OEM   Original Equipment Manufacturer
   r. OSHA  Occupational Safety and Health Act
   s. PC    Plumbing Contractor
   t. TIA/EIA Telecommunications Industry Association/Electronic Industries Association
   u. UL    Underwriters' Laboratories, Inc.

1.4 DEFINITIONS

   A. PROVIDE means to furnish, place, erect, connect, test, and turn over to Owner, complete and ready for the regular operation, the particular work referred to.

   B. INSTALL means to join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation, the particular work referred to.

   C. FURNISH means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories, and all other items customarily required for the proper and complete application for the particular work referred to.

   D. WIRING means the inclusion of all raceways, fittings, conductors, connectors, tape, junction and outlet boxes, connections, splices, and all other items necessary and/or required in connection with such work.

   E. CONDUIT means the inclusion of all fittings, hangers, supports, sleeves, etc.

   F. AS DIRECTED means as directed by the Architect or their representative.

   G. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within double partitions or installed within hung ceilings.

   H. ACCEPTED means as accepted by the Architect or their representative.
I. APPROVED means as approved by the Architect or their representative.

J. EQUAL means equivalent as approved by the Architect or their representative.

K. CONTRACTOR as stated herein shall mean Electronic Safety and Security Contractor.

1.5 PERMITS, CODES, AND INSPECTIONS

A. General: Contractor shall obtain and pay for all permits and inspections required by laws, ordinances, rules, and regulations having jurisdiction for work included under this Contract, and shall submit approval certificates to the Architect.

B. Codes: The installation shall comply fully with all local, county, and state laws, ordinances and regulations applicable to local area network and related communication installations.

C. The installation shall be in compliance with the requirements of the latest revisions of:

1. Building Communication International (BISCI)
2. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA)
3. Occupational Safety and Health Act (OSHA)
4. Institution of Electrical and Electronic Engineers (IEEE)
5. National Electric Code (NEC)
6. Underwriter's Laboratories, Inc. (UL)
7. National Electrical Manufacturer's Association (NEMA)
8. National Electrical Contractor's Association (NECA)
10. Legislative Act 235 (1965) - Handicapped
11. Legislative Act 287 (1974) - Excavation
13. Americans with Disabilities Act (ADA)
14. All approved published instructions set forth by equipment manufacturers.

D. The installation shall be in compliance with the requirements of:

1. Middle Department Inspection Agency (MDIA)
   a. Exception: Where the regulations of the local municipality require inspection services by an agency other than MDIA.

2. All local codes and ordinances in effect and having jurisdiction.
3. All requirements of electrical power utility companies.
4. All requirements of telephone utility companies.
5. All requirements of cable television utility companies.

E. Submit certificates issued by approved authorized agencies to indicate conformance of all work with the above requirements, as well as any additional certificates as may be required for the performance of this contract work.

F. Should any change in Drawings or Specifications be required to comply with governmental regulations, the Contractor shall notify Architect prior to execution of the work. The work shall
be carried out according to the requirements of such code in accordance with the instructions of the Architect and at no additional cost to the Owner.

G. Certificate of Inspection: The Contractor shall procure and pay for the Certificate of Inspection from MIDA, or other required inspection agency, and deliver it to the Architect before final payment is made.

1.6 VISITING PREMISES

A. General: The Bidder shall visit the project site before submitting his/her bid, in order to familiarize him/herself with existing conditions that may affect the work. It is the Contractor's responsibility to analyze existing conditions. Sufficient allowances shall be provided in the Contractor's bid to cover work, due to existing conditions, that will be required to complete this contract work.

B. By submission of a bid the Contractor is attesting that responsible personnel did, in fact, visit the site during the bidding period, and verified all existing pertinent conditions.

C. Contractor shall verify all measurements and dimensions at the site prior to submitting a bid.

1.7 SUBMITTALS

A. General: Follow the procedures specified in Division 1 and as stated below.

B. The Contractor shall submit a complete set of Project Documents and complete product data for the proposed system to the system vendor for review prior to submission to the Architect/Engineer. The System Vendor shall review the complete system package and provide documentation attesting to the system compliance with the extended system product and performance warranty. This documentation must accompany all submittals to the Architect/Engineer. Submittals will not be reviewed by the Architect/Engineer without the System Vendor approval documentation.

C. Submit for approval a complete Material Source of Supply and Subcontractor list for all work required under this project. Shop drawing submittals will not be reviewed until a complete Material Source of Supply and Subcontractor list is received.

D. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect, will not be processed.

E. Prepare and submit detailed shop drawings for materials, systems, and equipment as listed herein, including locations and sizes of all required openings in floor decks, walls and floors.

F. The work described in any shop drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job. Each submitted shop drawing shall include a certification that all related job conditions have been checked and that no conflict exists.
G. All shop drawings shall be stamped by the Contractor, indicating approval, and space shall be provided for the Engineer's stamp and the Architect's stamp.

H. All drawings shall be submitted sufficiently in advance of field requirements to allow ample time for checking and re-submittal as may be required. All submittals shall be complete and contain all required and detailed information.

I. Acceptance of any submitted data or shop drawings for material, equipment apparatus, devices, arrangement and layout shall not relieve the Contractor from responsibility of furnishing all items of proper dimensions, weight, capacities, sizes, quantity and quality as intended by the Contract. Such acceptance shall not relieve the Contractor from responsibility for errors, omissions or inadequacies of any sort on submitted data or shop drawings.

J. Each shop drawing shall contain job title and reference to the applicable drawing and specification article, including the Contractor’s drawings, specifications, and verification of compatibility with the systems involved.

K. Individual shop drawing submittals shall be provided for each specific material, system or equipment as identified herein. Submittals provided in other than this manner will be return without review.

L. All nameplate data shall be complete at time of equipment submittals - refer to other sections for identification requirements.

M. For each room or area of the building containing telephone backboards, fire alarm control panels, consoles, etc., coordination drawings are required to be submitted for review and acceptance at the time of the equipment submittal.

N. Equipment shall not be purchased until the shop drawing approval is received.

O. Shop Drawings shall show conformance with specified equipment characteristics, or Contractor shall assume responsibility for all deviations including all additional costs involved for the deviations.

P. The following is a list of some important material, equipment and systems that require shop drawing approval, refer to each section of this specification for additional submittal requirements:

   Outlet Boxes   Wiring/Cables
   Video Surveillance   Security System

Q. Submittals shall include plan, riser and wiring diagrams complete with all wiring and required equipment.

R. Product Options:

   1. The product manufacturers listed in each section are either the product the design is based on or a product that the Engineer feels would be an acceptable substitution if that product can meet the intent of the written specifications and the scheduled capacities. The Electronic Safety and Security Systems Contractor are responsible for ensuring that the substituted product complies with the intent of the specifications, the scheduled capacities and the drawings. Substitutions of manufacturers not listed are not permitted unless prior
approval is obtained from the Engineer as required by Part 2.2, SUBSTITUTIONS, of this specification section.

2. It will be the responsibility of the Contractor to pay any and all costs associated with any approved substitutions that impact the architectural layout, structure, electrical system(s), mechanical systems, and/or the plumbing systems, due to an increase in physical dimensions, weight, electrical requirements, connection sizes, etc., between the approved substitution item and the equipment item scheduled and/or indicated as the basis of design.

1.8 PROJECT DRAWINGS AND SPECIFICATIONS

A. Contractor shall carefully examine the Drawings and Specifications of all trades and report all discrepancies to the Architect in writing to obtain corrective action. No departures from the Contract Documents will be made without prior written approval from the Architect.

B. Questions or disputes regarding the intent or meaning of Contract Documents shall be resolved by the interpretation of the Architect. The Architect's interpretation is final and binding.

C. The Drawings and Specifications are not intended to define all details, finish materials, and special construction that may be required or necessary. The Contractor shall provide all installations complete and adequate as implied by the project documents.

D. Drawings are diagrammatic only and do not show exact routes of cabling and locations of equipment. The Contractor shall verify the work of all other trades and shall arrange his work to avoid conflicts. In the event of a conflict, the Contractor shall obtain corrective action from the Architect.

E. All work shall be considered new, unless noted otherwise.

1.9 COOPERATION AND COORDINATION WITH OTHER TRADES

A. This Contractor shall cooperate completely and coordinate work with the contractors of other trades. Due to the Project Schedule this Contractor will be required to phase the installation in accordance with the Electrical Contractor's work.

B. Prepare floor plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Specific equipment installations, including, but not limited to control cabinets for security, video surveillance systems.
2. Where additional conduit sleeves are required in order to limit cable lengths.
3. Wiring diagrams: Indicating field installed wiring and cabling layouts, equipment, and equipment connections.
1.10 PRODUCT LISTING
A. Prepare a listing of equipment and materials for the project.
B. Submit this listing as a part of the submittal requirement specified in Division 01.
C. When two or more items of same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, fasteners, and similar items used in work, except as otherwise indicated.
D. Provide products that are compatible within systems and other connected items.

1.11 NAMEPLATE DATA
A. Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplate in an accessible location.

1.12 RECORD DOCUMENTS
A. Prepare record documents in accordance with the requirements in Division 01.
B. When all work has been completed and before final acceptance, the Contractor shall furnish to the Architect a complete set of reproducible contract drawings clearly showing all contract work "as-built". Prior to delivery each drawing shall be signed and dated by the Contractor's project manager attesting to the accuracy of the as-built drawing.
C. In additional to the above referenced reproducible contract drawings, the Electronic Safety and Security Contractor shall furnish to the Architect a CD-Rom containing all of the floor plans. The floor plans shall be in AutoCAD 2000 format, and shall indicate the “as-built” conditions. A CD-Rom shall be provided to the Electronic Safety and Security Contractor prior the completion of the project, with the drawing files from the bid set of documents. The Electronic Safety and Security Contractor shall make changes to these files, indicating all changes made during construction, including tagging and room names. The Electronic Safety and Security Contractor shall make these changes or retain the services of a third party to make the changes.
D. Mark up a clean set of Specifications to indicate approved substitutions, change orders and actual equipment and materials used.

1.13 OPERATION MANUALS
A. Prepare operation manuals in accordance with Division 01. In addition to the requirements specified in Division 01, include the following information for equipment items:
   1. Description of function, normal operating characteristics and limitations, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's data of each piece of equipment including:
   a. Installation instructions.
   b. Drawings and Specifications.
   c. Parts list, including recommended items to be stocked.
   d. Complete wiring diagrams.
   e. Marked or changed prints locating all concealed parts and all variations from the original system design.
   f. Test and inspection certificates.

B. Format:
   1. Provide five (5) copies of each manual.
   2. Manuals to be 8-1/2 inches x 11 inches size in hard back 3-ring loose-leaf binders. Use more than one volume if required. Do not overfill binders.
   3. Submit one (1) copy to Architect. After review and acceptance, assemble other copies.
   4. Manuals to be completed and in Owner's hands prior to turning building over to Owner and at least 10 days prior to instruction to operating personnel.

1.14 WARRANTIES

A. Refer to the Division 1 for procedures and submittal requirements for warranties and to individual equipment specifications for additional warranty requirements. If a contradiction exists, the most demanding requirements shall prevail.

B. Compile and assemble the warranties specified in Division 28 into a separated set of vinyl covered, three-ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include date of beginning of warranty or bond; duration of warranty or bond; and names, address, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. Submit a single warranty stating that all portions of the work are in accordance with Contract requirements. Warrant all work against faulty and improper material and workmanship for a period of one (1) year from date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are specified herein, such longer term shall apply. Within 24 hours after notification, correct any deficiencies that occur during the warranty period at no additional cost to Owner, all to the satisfaction of the Owner. Obtain similar warranties from subcontractors, manufacturers, suppliers, and sub-trade specialists.

E. Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract Documents or which are damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the Owner.

PART 2 - PRODUCTS

A. Major items of equipment shall have manufacturer's name, address and catalog number on a plate securely attached in a convenient place. All equipment or apparatus of any one system
must be the product of one manufacturer, or approved equivalent products of a number of
manufacturer's that are suitable for use in a unified system.

B. All materials and equipment for which Underwriter's Laboratories have established standards
shall bear a UL label of approval.

C. In all cases where a device, function or item of equipment is herein referred to in the singular,
such reference shall apply to as many such items as are required to complete the installation.

D. All listed materials and equipment shown on drawings and/or specified herein, are indicative of
complete and whole units and shall be furnished as such.

E. In certain instances specific manufacturer/model/type and catalog numbers are set out herein or
on the drawings for the purpose of indicating required criteria for quality, function, and
acceptable physical size. Specifications, performance data, and descriptive data published by
the designated manufacturer shall be taken as minimum requirements for the item to be
provided.

F. Comply with manufacturer's printed instructions and recommendations as minimum criteria for
the installation of equipment.

G. Where proprietary names are used, whether or not followed by the words "or as approved", they
shall be subject to substitution only as approved by the Architect.

H. Where the contractor proposes substitute equipment he shall submit acceptable evidence to
indicate compliance with all requirements of the documents, including performance rating,
equivalent to the specified item. In instances where substituted equipment requires additional
material or work beyond that shown or required by the specified item, said additional material,
or work, shall be the responsibility of this Contractor, regardless of the trade involved.

I. All materials and equipment provided under this Contract shall be completely satisfactory and
acceptable in operation, performance and capacity. No approval, either verbal or written, of any
drawing, descriptive data, or samples of such materials, equipment, and/or appurtenances, shall
relieve this Contractor of his responsibility to turn over all items in perfect working order at
completion of the work.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades,
compliance labels, and other information needed for distinct identification; adequately packaged
and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing.
Protect stored equipment and materials from damage.
C. Coordinate deliveries of materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

3.2 SEQUENCE OF WORK

A. Construct work in a sequence in accordance with Division 01.

B. Due to current Project Schedule the Contractor will be required to phase the installation in accordance with the Electrical Contractor's work.

3.3 INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for installations of cabling.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
9. Coordinate the cutting and patching of building components to accommodate installation of equipment and materials.
10. Coordinate the installation of materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
11. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.

3.4 CLEANING

A. Refer to the Division 01 for general requirements for final cleaning.
3.5 TESTING

A. Contractor, at his own expense, shall make any and all tests directed by an inspection authority, or connector manufacturer, or the Architect, and shall provide all equipment, instruments and materials to make such tests.

B. Unless otherwise approved, all terminations shall be made and all components shall be in place, complete and operational, at time of final inspection and tests.

C. Time of such tests, the manner in which they are made and the results of the tests, shall be subject to approval.

D. Upon completion of work, all component parts, both singularly and as a whole, shall be set, calibrated, adjusted, and left in satisfactory operating condition to suit load conditions, by means of instruments furnished by the Contractor.

E. Complete testing of equipment and systems shall be provided throughout this project.

F. Industry standards shall apply except as otherwise specified.

G. Provide all labor, premium labor, and materials required by field-testing as specified in the Contract Documents and as required.

H. Notify the Architect seven (7) days prior to the testing dates. Upon completion of a test, a statement of certification shall be forwarded to the Architect for his approval.

I. Conduct tests at a time agreeable to the Architect. Provide premium labor as necessary.

J. Products that are found defective or do not pass such tests shall be removed and replaced at the Contractor's expense. Tests shall be repeated.

3.6 INSTRUCTIONS TO THE OWNER

A. After the tests and adjustments have been made, approved factory-authorized system representatives and the Contractor shall fully instruct Owner in all details of operation and maintenance of equipment installed under this Contract. Dates and times of such instructions shall be as directed by Owner, including any necessary weekend or after-hours instruction.

B. Additional instruction requirements are included in each section of the Specifications.

C. The Contractor shall video tape all instruction sessions. Prepare a separate video tape for each system as shown on the schedule below. Clearly label the tape with the title “INSTRUCTIONS FOR THE USE OF ”, on both the face and the spine, in typewritten letters. Two (2) copies of each video tape shall be given to the Owner at the completion of the Contract; one (1) set for the maintenance staff and one (1) set for the administrative staff.

D. Prepare an instructional training form indicating the topic of instruction, the date, the time, the purpose of instruction and lines for signatures of attendees. Each person attending the instruction shall print their name and sign the form. Provide a copy of the completed form to the Owner in the O & M manual as proof of instructional training. The Contractor shall keep the original in the Contractor's project file.
E. The attached schedule indicates the extent of training.

<table>
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Notes:

1. Format: Provide training in the following format:
   - I = initial meeting to discuss system operation, safety issues, maintenance issues
   - 1F = follow-up session, 1 month from initial session
   - 2F = follow-up session, 2 months from initial session

2. Length: Provide the length of instruction as follows:
   - 1, 2, 3, etc. indicates the number of hours of training; does not include travel time, setup time, question/answer time.
   - A/R = as required by Owner or the number of attendees

3. Attendees:
   - A = Administrative Staff, as determined by Owner’s representative
   - M = Maintenance Staff, as determined by Owner’s representative
   - T = Teaching Staff, schedule multiple sessions to limit instructional session size to 15 people

4. Specification Section:
   - Refer to the individual specification sections for additional training requirements.

END OF SECTION 28 0100
SECTION 280500 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Requirements of the following Division 28 Sections apply to this section:

C. Division 28 section 28 01 00 “Basic Electronic Safety and Security Systems Requirements”.

1.2 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with electrical installations as follows:

1. Firestopping.
2. Locations
3. Scaffolding
4. Painting

PART 2 - PRODUCTS

2.1 FIRESTOPPING

A. Acceptable Manufacturers: Subject to compliance with UL requirements, one of the following:

1. 3M
2. Tremco
3. International Protective Coatings
4. Nelson
5. Rectorseal/Metacaulk

B. Use only that manufacturer listed in UL Fire Resistance Directory for the UL system involved.

C. All firestopping materials used on this project shall be the products of one manufacturer. Each trade shall use products of the same manufacturer.

D. Standards: The firestop systems and products shall have been tested in accordance with the procedures of U.L. 1479 (ASTM E814-81) and material shall be UL classified as Fill, Void or Cavity Materials for use in Through-Penetration Firestops. The firestop system shall comply with NEC Paragraph 300-21. All work shall comply with NFPA 101-Life Safety Code, Latest Edition.
PART 3 - EXECUTION

3.1 GENERAL

A. All construction under this contract shall be completed in a neat and craftsman like manner. Work that, in the judgment of the Architect, is not satisfactorily installed shall be removed and replaced to the Architect's satisfaction, at the Contractor's expense.

B. Housekeeping: Throughout construction, all work areas and storage areas shall be kept clean. The Contractor shall keep all items clean of dirt, rust, dust, and finger marks.

3.2 FIRESTOPPING

A. Where communication conduits, conduit sleeves, wire ways and other raceways or cables pass through fire partitions, fire walls, fire floors, or smoke walls, the Contractor shall provide a fire or smoke stopping that provides an effective barrier against the spread of fire, smoke, or gases.

B. Installation of Fire-Stopping Materials: Install materials to fill openings around services penetrating floors and walls and provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Install materials in accordance with printed instructions of the UL Fire Resistance Directory and per manufacturer's published instructions.

C. All cables that are installed in conduit sleeves or in wire ways through fire or smoke floors or partitions shall be provided with an equally rated re-enterable U.L. listed fire and smoke rated silicone RTV foam in the opening.

D. Examine fire/smoke-stopped areas to ensure proper installation before concealing or enclosing areas.

E. Keep areas of work accessible until inspection by applicable code authorities.

3.3 LOCATIONS

A. Obtain written approval of locations of all devices from the Owner and Architect prior to rough-in/installation. The owner reserves the right to move any or all communication devices prior to installation, at no additional cost.

B. Contractor shall obtain detailed and specific information regarding location of all equipment. Final locations may differ from those indicated on Drawings. Work improperly placed because of Contractor's failure to obtain this information shall be relocated and reinstalled as directed, without additional costs to the Contract.

C. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of equipment without prior written approval.
3.4 SCAFFOLDING

A. The Contractor shall furnish, set, erect, and maintain all scaffolding, aerial equipment, and ladders required in the installation of this Contract work.

B. Install temporary platforms so as to be supported only by the existing steel truss framework. Do not allow any additional loading from construction operations to transfer to suspended lath and plaster ceilings.

3.5 PAINTING

A. Except in Mechanical Rooms and Electrical Rooms all exposed items provided or installed under this Contract shall be painted in accordance with Division 1 requirements.

B. Unless painting is provided by others, as elsewhere specified, all painting for items furnished or installed under this Contract shall be the responsibility of this Contractor.

C. Factory-painted equipment cabinets and trim shall not be field-painted except for touching up scratches or damage where necessary to achieve like-new finish. Touching up shall be done after equipment is in its final location.

D. Items to be painted shall be cleaned and degreased and shall be free of dirt, rust and corrosion prior to application of paint.

E. All paint shall be applied in accordance with all the manufacturer's recommendations (i.e. temperature, dew point, ventilation).

END OF SECTION 28 0500
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PART 1 - GENERAL

1.1  RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to this section.

B. Requirements of the following Division 28 Sections apply to this section:
   2. Common Work Results for Electronic Safety and Security.

1.2  SUMMARY

A. This Section includes cables designed and used for electrical transmission in control, data, and signal circuits including:
   1. Twisted Pair cable.
   2. Coaxial cable.
   3. Video Pair cable.

1.3  SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Submittals shall be made with the corresponding system submittal as complete systems including all required accessories and special installation tools (i.e., termination hardware).

C. Product Data for control/signal transmission cable and connectors, including the following cable transmission characteristics:
   1. Mutual Capacitance
   2. DC Resistance
   3. Characteristic Impedance
   4. Attenuation
   5. Near-end Crosstalk (NEXT)
   6. Nominal Velocity of Propagation

D. Manufacturers complete installation instructions including the following information:
   1. Minimum bend radius
   2. Maximum pulling tension
3. Recommended installation of pulling points (i.e., every 180 degrees of bends in the conduit, or every 150 feet of conduit)
4. Recommended pulling lubricants

E. Product Certificates signed by the communication system manufacturers, certifying that the cables and termination hardware is suitable for the connected equipment and is certified to meet the standards described in Quality Assurance below.

F. Provide information regarding all termination, splitting and splicing connectors that will be required to complete this installation. This information shall include complete specifications and installation instructions including tightening requirements.

1.4 QUALITY ASSURANCE

A. Connected Equipment Manufacturer Approval: Where cables specified in this Section are used to provide signal paths for systems specified in other sections of these Specifications or for systems furnished under other contracts, obtain review of the cable characteristics and approval for use with the connected system equipment by the connected equipment manufacturers.

B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."

C. Toxicity: Comply with applicable codes and regulations regarding toxicity of combustion products of materials used in control/signal transmission media.

D. UL Compliance: Comply with applicable requirements of UL Standard 910 "Test Method for Fire and Smoke Characteristics of Cables Used in Air Handling Spaces." Provide products that are UL-listed and labeled for such use.

E. NEMA/ICEA Compliance: Comply with NEMA/ICEA Standard WC 41, "Coaxial Communication Cable."

F. Comply with the following Electronic Industries Association (EIA) and Telecommunications Industry Association (TIA) Standards:

1. EIA/TIA-568, "Commercial Building Telecommunications Wiring Standard"
2. EIA/TIA-569, "Commercial Building Standard for Telecommunications: Pathways and Spaces"
3. EIA/TIA-570, "Residential and Light Commercial Telecommunications Wiring Standard"
4. TIA/EIA-606, "The Administration Standard of the Telecommunications Infrastructure of Commercial Building"
5. TSB-36, Technical Systems Bulletin, "Additional Cable Specifications for Unshielded Twisted-Pair Connecting Hardware"
7. EIA Standards EIA-230, "Color Marking of Thermoplastic Wire" and
8. EIA-258, "Semi-Flexible Air Dielectric Coaxial Cables and Connectors, 50 Ohms."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver cable factory-packaged in containers or reels. Store in clean dry space and protect products from damaging fumes and traffic. Handle wire and cable carefully to avoid damage.

PART 2 - PRODUCTS

2.1 GENERAL

A. All cable installed in cable tray shall have a plenum rating.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

1. Cable:
   a. AT&T Network Systems
   b. The Siemon Company
   c. Belden Div; Cooper Industries
   d. Mohawk Wire & Cable Corporation
   e. West Penn Wire Corporation
   f. AMP
   g. General Cable

2. Connectors:
   a. Thomas & Betts Corporation
   b. 3M Company
   c. Blonder Tongue
   d. Macom
   e. AMP

2.3 CONTROL/SIGNAL TRANSMISSION CABLE AND CONNECTORS

A. General: Provide control/signal transmission cable and connectors of manufacturer's standard materials as indicated on the drawings. All cables shall be designed and constructed as recommended by the system/equipment manufacturer, for a complete installation and for applications indicated.
2.4 APPLICATIONS

A. Install control/signal cables and connectors for the following systems:

1. For building protection systems
2. Surveillance systems.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONTROL/SIGNAL CABLE AND CONNECTORS

A. Conductors and cables for communications and signal systems shall be installed with a minimum 18" clearance from light fixtures, electrically operated equipment and all wiring operating at 120 or more volts.

B. Conductors and cables for communications and signal systems shall be type, size and insulation as recommended by manufacturer and approved. Install in accordance with manufacturer's written instructions and in compliance with NEC.

C. Coordinate installation with other Work.

D. Install without damaging conductors, shield, or jacket.

E. Do not either in handling or installation bend cable to smaller radii than minimum recommended by manufacturer.

F. Ensure that minimum manufacturer's recommended pulling tensions are not exceeded.

G. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway.

H. Use pulling compound or lubricant where necessary; compound used must be approved by the cable manufacturer.

I. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

J. No splices are allowed except at indicated splice points.

K. Use splice and tap connectors that are compatible with media material.

L. Tighten connectors and terminals, including screws and bolts in accordance with manufacturer's published instructions or torque tightening values.
3.2 COLOR CODING

A. All wiring for communications and signal systems shall be color coded, using black, red, white, yellow, blue and brown with tracers as required. There shall be no two wires of same trace color in the same cable. This color coding shall be consistent and continuous throughout the system.

3.3 TRAINING

A. Provide adequate length of conductors within electrical enclosures and at punchdown blocks. Train the conductors to termination points with no excess.

3.4 FIELD QUALITY CONTROL

A. Prior to usage, test wiring for electrical continuity and for short circuits. In addition, test the cable installation with a time domain reflectometer with strip chart recording capability and anomaly resolution to within one foot in runs up to 1,000 feet in length.

B. Test all cable segments for faulty connectors, splices, terminations, and the integrity of the cable and its component parts.

C. Documentation: Use the above time domain reflectometer to make a strip chart recording of transmission characteristics, wave form, and performance of all segments of the installation at the time of commissioning. Bind the recordings in a cable record book indexed for easy reference during future maintenance operations and turn book over to the Owner's authorized representative.

D. Replace malfunctioning transmission media with new materials, then retest until satisfactory performance is achieved.

3.5 COMMISSIONING

A. Subsequent to hookups of control/signal transmission media, operate control/signal systems to demonstrate proper functioning. Replace malfunctioning media with new materials, and then retest until satisfactory performance is achieved.

END OF SECTION 28 0523
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1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Requirements of the following Division 28 Sections apply to this section:
   1. Division 28 section 280100 “Basic Electronic Safety and Security Systems Requirements”.
   2. Division 28 section 280500 “Common Work Results for Electronic Safety and Security”.

1.2 SUMMARY

A. This Section includes secure support from the building structure for communication items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. All supports shall utilize threaded fasteners for all connections/attachments. The use of clips or clip-on type supports is not acceptable.

C. Types of supports, anchors, sleeves, and seals specified in this section include the following:
   1. Clevis hangers
   2. Riser clamps
   3. C-clamps
   4. I-beam clamps
   5. Conduit straps
   6. Round steel rods
   7. Lead expansion anchors
   8. Toggle bolts
   9. Wall and floor seals

D. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly in other Division-28 sections.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve, and seal.
C. Shop Drawings: Submit dimensioned drawings of fabricated products, indicating details of fabrication and materials.

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing supporting device work similar to that required for this project.

C. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of supporting devices.

D. MSS Compliance: Comply with applicable MSS standard requirements pertaining to fabrication and installation practices for pipe hangers and supports.

E. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

F. UL Compliance: Provide components that are UL listed and labeled.

G. FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe and cable.

H. Components shall be listed and labeled by ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

   1. Slotted Metal Angle and U-Channel Systems:
      a. Allied Tube & Conduit
      b. American Electric
      c. B-Line Systems, Inc.
      d. Cinch Clamp Company, Inc.
      e. Elcen Metal Products Company
      g. Haydon Corporation
      h. Kin-Line, Inc.
      i. Midland-Ross Corporation
j. Power-Strut Div; Van Huffel Tube Corporation
k. Unistrut Diversified Products

2. Anchors:
   a. Abbeon Cal Inc.
   b. Ackerman Johnson Fastening Systems Inc.
   c. Elcen Metal Products Company
d. Ideal Industries, Inc.
e. Joslyn Mfg and Supply Company
f. McGraw Edison Company
g. Rawl Plug Company Inc.
h. Star Expansion Company
i. U.S. Expansion Bolt Company
j. Hilti, Inc.

2.2 U-CHANNEL STRUT SYSTEMS

A. Provide U-channel strut system for supporting communication equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" diameter holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U-channel and are of the same manufacturer:

1. Fixture hangers
2. Channel hangers
3. End caps
4. Beam clamps
5. Wiring stud
6. Thin wall conduit clamps
7. Rigid conduit clamps
8. Conduit hangers
9. U-bolts

2.3 SUPPORTING DEVICES

A. Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

1. Clevis Hangers: For supporting 2" rigid metal conduit; galvanized steel; with 1/2" diameter hole for round steel rod; approximately 54 pounds per 100 units.
2. Riser Clamps: For supporting 5" rigid metal conduit; black steel; with 2 bolts and nuts; and 4" ears; approximately 510 pounds per 100 units.
3. Reducing Couplings: Steel rod reducing coupling 1/2" x 5/8"; black steel; approximately 16 pounds per 100 units.
4. C-Clamps: Black malleable iron; 1/2" rod size; approximately 70 pounds per 100 units.
5. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock, 3/8" cross bolt; flange width 2"; approximately 52 pounds per 100 units.
6. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approximately 7 pounds per 100 units.
7. Two-Hole Conduit Straps: For supporting 3/4" rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
8. Hexagon Nuts: For 1/2" rod size; galvanized steel; approximately 4 pounds per 100 units.
9. Round Steel Rod: Black steel; 1/2" diameter; approximately 67 pounds per 100 feet.
10. Offset Conduit Clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 pounds per 100 units.

2.4 ANCHORS
A. Provide anchors of types, sizes and materials indicated; and having the following construction features:
   1. Lead Expansion Anchors: 1/2", approximately 38 pounds per 100 units.
   2. Toggle Bolts: Springhead; 3/16" x 4"; approximately 5 pounds per 100 units.

2.5 SLEEVES AND SEALS
A. Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:
   1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

2.6 COATINGS
A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.7 FABRICATED SUPPORTING DEVICES
A. General: Shop or field-fabricated supports or manufactured supports assembled from U-channel components.
B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION
3.1 GENERAL
A. Provide supporting devices that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Contractor’s option.
B. Install hangers, anchors, sleeves, and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installations of supporting devices.
C. Coordinate with the building structural system and electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
D. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
E. Obtain approval from the Architect before drilling or cutting structural members.
F. Install surfacemounted cabinets with minimum of four anchors.

3.2 MISCELLANEOUS SUPPORTS
A. Support miscellaneous components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, boxes, and other devices.

3.3 FASTENING
A. Unless otherwise indicated, fasten items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, boxes, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
2. Holes cut into reinforced concrete beams or in concrete shall not cut reinforcing bars. If the Contractor cuts into any reinforcing bars, stop work and notify the Architect immediately. Fill holes that are not used.
3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
3.4 TESTS

A. Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors.
2. Toggle bolts.

B. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

END OF SECTION 28 0529
SECTION 280534 - BOXES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 28 Sections apply to this section:

1. Division 28 Section 28 0100 “Basic Electronic Safety and Security Systems Requirements”.
2. Division 28 Section 28 0500 “Common Work Results for Electronic Safety and Security”.

1.2 SUMMARY

A. This section includes boxes and fittings for communication installations and certain types of electrical fittings not covered in other sections. Types of products specified in this Section include:

1. Outlet and device boxes.

B. In general, all outlet boxes, conduit, and raceway shall be provided by the Division 26 Electrical Contractor. The Electronic Safety and Security Contractor shall provide any miscellaneous outlet boxes, conduit and raceway at the communication system racks only. The outlet boxes, conduit, and raceway provided by the Electronic Safety and Security Contractor shall supplement that provided by the EC in order to accomplish a neat and orderly installation.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

1.4 QUALITY ASSURANCE

A. Nationally Recognized Testing Laboratory Listing and Labeling (NRTL): Items provided under this section shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

B. National Electrical Code Compliance: Components and installation shall comply with NFPA 70 "National Electrical Code."

C. UL Compliance: Comply with applicable requirements of UL 50, UL 514 Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings that are UL listed and labeled.
D. NEMA Compliance: Comply with applicable requirements of NEMA Standards/Pub No.’s 0S1, 0S2, and Pub 250 pertaining to outlet and device boxes, covers and box supports.

E. Federal Specification Compliance: Comply with applicable requirements of FS W-C-586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps".

PART 2 - PRODUCTS

2.1 BOXES AND FITTINGS, GENERAL

A. Provide electrical boxes, and fittings of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

2.2 OUTLET AND DEVICE BOXES

A. Outlet Boxes: Provide galvanized flat rolled sheet steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Provide outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

B. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.

C. Manufacturers: Subject to compliance with requirements, provide interior outlet boxes of one of the following:

1. American Electric
2. Appleton Electric; Emerson Electric Company
3. Bell Electric; Square D Company
5. Midland-Ross Corporation
6. OZ/Gedney; General Signal Company
7. Thepitt
8. Hubbell, Inc.
9. Thomas & Betts Company
10. Pass and Seymour, Inc.
2.3 BUSHINGS, KNOCKOUT CLOSURES, AND LOCKNUTS

A. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes to suit respective installation requirements and applications.

B. Manufacturers: Subject to compliance with requirements, provide bushings, knockout closures, locknuts and connectors of one of the following:

1. Adalet-PLM Division; Scott Fetzer Company
2. AMP, Inc.
3. Arrow-Hart Division; Crouse-Hinds Company
4. Appleton Electric Company; Emerson Electric Company
5. Midland-Ross Corporation
6. Midwest Electric; Cooper Industries Inc.
7. OZ/Gedney Company; General Signal Company
8. RACO Division; Harvey Hubbell Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: The Electrical Contractor shall provide all junction boxes for communication devices in walls and floors. The Communication Contractor shall provide any miscellaneous junction boxes required for a neat and complete installation.

B. Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation" and in accordance with recognized industry practices to fulfill project requirements.

C. Locations:

1. Install items where required to suit code requirements and installation conditions.
2. Locate and install boxes to allow access. Where installation is otherwise inaccessible, coordinate locations and sizes, and provide required access doors.
3. Locate and install to maintain headroom and to present a neat appearance.
4. Position recessed outlet boxes accurately to allow for surface finish thickness.

D. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or busing on rounded surfaces.

1. Provide electrical connections for installed boxes.
2. Subsequent to installation of boxes, protect boxes from construction debris and damage.
3. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
4. Support and fasten items securely in accordance with Division 28 Section "Hangers and Supports for Electronic Safety and Security Systems."
5. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.
6. Remove sharp edges where they may come in contact with wiring or personnel.

3.2 GROUNDING

A. Electrically ground metallic boxes and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the box or enclosure.

3.3 CLEANING AND FINISH REPAIR

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions, and weld marks.

B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the manufacturer.

C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating recommended by the manufacturer.

END OF SECTION 28 0534
SECTION 28 0553 - IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   B. Requirements of the following Division 28 Sections apply to this section:
      1. Division 28 Section 28 0100 “Basic Electronic Safety and Security Requirements”.
      2. Division 28 Section 28 0500 “Common Work Results for Electronic Safety and Security”.

1.2 SUMMARY
   A. This Section includes identification of communication cables, equipment, and installations. It includes requirements for identification components including but not limited to the following:
      1. Identification labeling for cables.
      2. Operational instruction signs.
      3. Equipment labels and signs.
   B. Refer to Division-01 for equipment and system nameplates, and performance data; not work of this section.
   C. Refer to other Division 28 sections for additional specific identification requirements associated with specific items.

1.3 SUBMITTALS
   A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
   B. Product Data: Manufacturer's data for each type of product specified.
   C. Schedule of identification nomenclature to be used for identification signs and labels.
   D. Samples of each color, lettering style, and other graphic representation required for identification materials; samples of labels and signs.
1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical or communication identification products of types required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing identification work similar to that required for this project.

C. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

D. UL Compliance: Comply with applicable requirements of UL Std. 969, "Marking and Labeling Systems", pertaining to identification systems.

E. ANSI Compliance: Comply with applicable requirements of ANSI Std. A13.1 "Scheme for the Identification of Piping Systems", with regard to type and size of lettering for cable labels.

F. NEMA Compliance: Comply with applicable requirements of NEMA Std. No's. WC-1 and WC-2 pertaining to identification of control conductors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following (for each type marker):

1. Ideal Industries, Inc.
2. Panduit Corporation
3. Seton Name Plate Company

2.2 ELECTRICAL IDENTIFICATION PRODUCTS

A. Adhesive Marking Labels for Raceway and Metal-clad Cable: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service (Control, Fire, etc.).

1. Label Size: as follows:

   b. Raceways Larger than 1-Inch: 1-1/8 inches high by 8 inches long.

B. Cable Identification Bands:

1. General: Provide manufacturer's standard plastic wrap-around cable markers, of size required for proper application, and numbered to show cable identification.

C. Equipment Labels
1. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening.

2. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.

D. Lettering and Graphics

1. General: Coordinate names, abbreviations and other designations used in identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

E. Fasteners for Plastic-Laminated and Metal Signs

1. Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers. Exception: Where specifically approved contact type permanent adhesive may be used in areas where screws cannot or should not penetrate substrate.

PART 3 - EXECUTION

3.1 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

B. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.

C. Install identification devices as indicated, in accordance with manufacturer's written instructions and requirements of NEC.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Regulations: Comply with governing regulations and requests of governing authorities for the identification of work.

3.2 CABLE IDENTIFICATION

A. Apply cable identification on each cable in each cabinet. Match identification with marking system used on shop drawings, contract documents, and similar previously established identification for project's work.
B. Each cable shall be marked at both ends.

C. The Contractor shall review the identification scheme with the Owner prior to commencing work. The identification scheme shown on the floor plans is based on architectural room numbers and may not necessarily be the final post-construction room numbers.

3.3 OPERATION SIGNS

A. Provide instruction signs with approved legend where instructions or explanations are needed for system or equipment operation.

3.4 INSTALLATION

A. Provide equipment identification labels of engraved plastic-laminate on each major unit of communication equipment in the building, including each rack, cabinet and main network switch, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, with 1/2-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), white lettering in black field. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each communication system component.

1. Security-monitoring master station or control panel.

B. Provide labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

END OF SECTION 28 0553
SECTION 281100 - ELECTRONIC SAFETY AND SECURITY EQUIPMENT GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SUMMARY
A. This Section includes solid grounding of communications systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.
B. The Electrical Contractor shall be responsible for grounding equipment provided in the Electrical Contract, HVAC Contract, Plumbing Contract, and General Contract.
C. The Communication Contractor shall be responsible for proper grounding of all racks, cabinets, and active components as shown on the Drawings and as specified herein.

1.3 SUBMITTALS
A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
B. Product data for connectors and connection materials, and grounding fittings.
C. Field-testing organization certificate, signed by the Contractor, certifying that the organization performing field tests complies with the requirements specified in Quality Assurance below.
D. Report of field tests and observations certified by the testing organization.

1.4 QUALITY ASSURANCE
A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, whose products have been in satisfactory use in similar service for not less than 3 years.
B. Installer: Qualified with at least 3 years of successful installation experience on projects with communications grounding work similar to that required for project.
C. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
1. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. Field-Testing Organization Qualifications: To qualify for acceptance, the independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code" (NEC).

F. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to grounding and bonding.

G. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to grounding.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. B-Line Systems Inc.
2. Burndy Corporation
3. Crouse-Hinds Company
4. Electrical Components Division; Gould Inc.
5. General Electric Supply Company
6. Ideal Industries, Inc.
7. Thomas and Betts Corporation

B. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

C. Conductor Materials: Copper with 98% conductivity.

2.2 WIRE AND CABLE CONDUCTORS

A. General: Comply with Division 26 Section "Low Voltage Electrical Power Cables."

B. Equipment Grounding Conductor: Green insulated.

C. Grounding Electrode Conductor: Stranded cable.

D. Bare Copper Conductors: Conform to the following:


E. Tinned Conductors: ASTM B-33.

2.3 MISCELLANEOUS CONDUCTORS

A. Ground Bus: Bare annealed copper bars of rectangular cross section.

B. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.

C. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

D. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gage bare copper wire; 3/4" wide, 9-1/2" long; 48,250 cm. Protect braid with copper bolt hole ends with holes sized for 3/8" diameter bolts.

2.4 CONNECTOR PRODUCTS

A. General: Listed and labeled as grounding connectors for the materials used.

B. Pressure Connectors: High-conductivity-plated units.

C. Bolted Clamps: Heavy-duty units listed for the application.

2.5 GROUNDING ELECTRODES

A. Signal and Communications: For communication systems, provide a #4 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each rack, cabinet or central equipment location.

B. Bonding Plates, Connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.

C. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.1 GENERAL

A. Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), bonding jumper braid, surge arresters, and additional accessories needed for complete
installation. Where more than one type unit meets indicated requirements selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

3.2 INSPECTION
A. Installer must examine areas and conditions under which grounding connections are to be made and notify the Architect in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

3.3 APPLICATION
A. Provide grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

3.4 INSTALLATION
A. General: Ground communications systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.
B. Coordinate with other electrical work as necessary to interface installation of communication system grounding system with other work.
C. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

3.5 CONNECTIONS
A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
   2. Make connections with clean bare metal at points of contact.
   3. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
B. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.
3.6 FIELD QUALITY CONTROL

A. Upon Completion of installation of communications grounding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 3 ohms, take appropriate action to reduce resistance to 3 ohms, or less, by driving additional ground rods and/or by chemically treating soil encircling ground rod; then retest to demonstrate compliance.

B. Independent Testing Organization: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below.

C. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground resistance level is specified, at service disconnect enclosure ground terminal.

D. Ground/resistance maximum values shall be as follows:

E. Equipment rated 500 kVA and less: 10 Ohms

F. Deficiencies: Where ground resistances exceed specified values, and if directed, modify the grounding system to reduce resistance values. Where measures are directed that exceed those indicated the provisions of the Contract, covering changes will apply.

G. Report: Prepare test reports, certified by the testing organization, of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

END OF SECTION 28 1100
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SECTION 28 1300 - ACCESS CONTROL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The SMS contractor shall coordinate equipment compatibility with the existing Andover SMS vendor before ordering and installing any security systems specified. The new SMS Contractor shall make all final connections to the equipment in his scope of work. The requirements of division 28 and Division 26 apply to this section.

B. All access control systems specified in this specification shall be monitored and controlled over the school districts IP network utilizing the existing Schneider Electric Andover Continuum Integrated Security system software and its security management data base residing on the two districts SQL-Servers. All access control system shall be seamlessly integrated with the existing district wide security system and operators workstation to provide one unified security system of control and monitoring. The districts SMS system provides control, monitoring, and triggers specific HVAC sequences along with CCTV and access control sequences and provides a graphical display on the operator’s integrated workstation of the access control system and related events. The SMS contractor shall coordinate equipment compatibility with the existing Andover SMS contractor before ordering and installing the access control systems specified. The SMS contractor shall make all final connections to the equipment under their scope of work. The SMS contractor shall be responsible to provide all labor, cost, and documentation to assist the existing SMS Andover contractor with the integration requirements of the installed SMS systems. The requirements of division 27, 28 and 26 apply to this section and the SMS contractor shall coordinate their work as it applies to those divisions.

C. The new SMS system shall be capable of being seamlessly integrated into the existing Andover building management HVAC system of control should the owner desire to have an integrated HVAC/Security management system in the future.

D. The school district shall be responsible for furnishing the required IP drops and IP addresses and the security contractor shall be responsible for their respective system IP termination and system set up and operational check out.

E. The SMS is designed to secure the designated CUSTOMER facilities. The work to be provided, in addition to designing, furnishing and installing the SMS, shall include the following:

1. Provide integration of existing software that meets specified contract requirements.
2. Verification that proposed equipment and devices furnished is adequate for the intended purpose.
3. Perform a layout check to ensure that adequate access is available for construction, installation, and maintenance of equipment and devices furnished; however, the Contractor is not responsible for furniture. The Contractor shall consult the CUSTOMER in the design of the workplace.
4. Perform acceptance tests to show system is properly installed and that it meets the specifications and applicable codes.
5. System Administrator shall be responsible to configure and maintain the system. System utilities shall be provided for the System Administrator to use. Software for backups and log file maintenance shall also be provided.

1.2 SCOPE OF SYSTEM

A. Basic System Characteristics

1. Any alternate system shall comply with all of the capabilities of the specified system and be pre-approved by the specifying engineer, no exception.
2. The SMS shall provide an integrated solution through the use of control and digital video recording hardware and PC workstation-based software for Access Control, Security/Intrusion Detection, CCTV Integration, photo imaging, Digital Video Surveillance, Elevator Control, Time & Attendance, Fire & Life Safety, and Visitor Management.
3. This SMS shall provide a true multi-tasking, multi-workstation client-server architecture based on PC-based client platforms running Microsoft’s Windows 2000/XP/Seven Workstation operating system and PC-based server(s) running Microsoft Windows 2000/XP/2003 Server and Microsoft’s SQL 2000 Server relational database management system.
4. The SMS client-server architecture shall communicate with native TCP/IP Intelligent Distributed Network Controllers (IDNC) over an existing CUSTOMER owned Ethernet TCP/IP enterprise network and utilize the school districts existing SMS database.
5. The SMS shall be capable of controlling a minimum of 100,000 doors, 4,000,000 card holders; monitoring up to 100,000 supervised input points, and activating up to 100,000 output control points.

1.3 MANUFACTURE

A. Equipment in this Specification is based on products manufactured by Andover Continuum and controlled through the existing Andover SMS and related software and other specific manufacturers, and is intended as the standard equipment to be furnished which shall be consistent and compatible with the existing security system. All manufacturers’ published specifications pertaining to this specialization shall have the same force and effect as if shown here in full.

B. Bases of Design; Schneider Electric Andover Continuum, no exception.

C. It shall be the responsibility of the new SMS contractor to provide all the required labor and programming to seamlessly integrate the new SMS system and its DDC points, graphics, alarms, security functions, etc., into the existing Andover security system, workstations, and the district server to provide one unified Native BACnet integrated SMS system of control and monitoring. The new SMS contractor shall solely be responsible for all seamless integration requirements of the existing Andover Continuum security system.

D. General Requirements:
1. Contractor shall provide the SMS as shown on the drawing and specified herein including but not limited to the following:
   
a. Alarm monitoring and display workstation(s).
b. Integrated workstation(s).
c. Digital video recorder(s).
d. RemoteView workstation(s).
e. Visitor Management System (VMS) Integration
f. File server(s).
g. Workstation peripherals.
h. SMS new and existing integration requirements
i. Access control and alarm monitoring controller(s).
j. Intelligent distributed network controller(s).
k. I/O modules.
l. Field hardware devices.
m. Software modules required for specification operation.

1.4 WORK BY OTHERS

A. The Security Subcontractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others’ work.

1.5 RELATED SECTIONS

A. The General Provisions of the Contract, including General, Supplementary, Special Conditions, and Division 01 - General Requirements, apply to work specified in this section and the other sections of Division 26 and 28. Subcontractor must familiarize himself with the terms of the above documents

B. Requirements of the following Division 28 Sections apply to this section:

1. 28 0100 Basic Electronic Safety and Security Systems Requirement
2. 28 0500 Common Work Results for Electronic Safety and Security
3. 28 0523 Control Voltage Cabling for Electronic Safety and Security
4. 28 0529 Hangers and Supports for Electronic Safety and Security Systems
5. 28 0534 Boxes and Fittings
6. 28 0553 Identification for Electronic Safety and Security Systems
7. 28 1100 Electronic Safety and Security Equipment Grounding
8. 28 1600 Intrusion Detection
9. 28 2300 Video Surveillance

1.6 REFERENCED AND SYSTEM CERTIFICATIONS

A. Design and operation of the SMS shall conform to the following referenced codes, regulations, and standards as applicable:
1. National Electrical Code (NEC)
2. UL 294 Access Control Systems
3. UL 1076 Line Supervision
4. FCC Rules and Regulations
5. Part 15, Radio Frequency Devices
6. National Electrical Manufacturers Association (NEMA)
7. Applicable Federal, State and Local laws, regulations, codes
8. Americans with Disabilities Act (ADA)
9. 21 CFR Part 11

1.7 QUALITY ASSURANCE

A. Manufacturer
   1. Andover Continuum, specializing in Security/Access Control Systems with a minimum of five years experience.

B. Installer

1.8 SUBMITTALS

A. Contractor shall submit all items in accordance with the requirements of Division 1. Submittals, and shall include, but not be limited to the following:

   1. Model numbers of all components furnished on the job.
   2. Manufacturer’s installation instructions.
   3. Manufacturer’s catalog data sheets for all components.
   4. Input power requirements for all components.
   5. Complete engineered drawings indicating:
      a. Layout, wiring diagrams, and dimensions.
      b. Point-to-point wiring diagrams for all devices.
      c. Termination details for all devices.
      d. Single-line system architecture drawings representing the entire system.
      e. Where the proposed system complies fully, such shall be indicated by placing the word “comply” opposite the paragraph number.
      f. Where the proposed system does not comply, but accomplishes the stated function in a manner different from that described, such shall be indicated by placing the words “comply with intent” opposite the paragraph number, followed by a full description of the deviation. Where a full description of the deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question and an “exception” is taken.
      g. Where the system does not offer the functionality stated, such shall be indicated by placing the word “exception” opposite the paragraph number.
      h. Any proposal submitted which does not include a paragraph item-by-item statement of compliance as described herein shall be deemed non-responsive.
6. Operation Data, including operating instructions.
7. Maintenance Data, including maintenance and repair procedures.
8. Training Syllabus, including course outlines for each of the end user training programs.
   The course outlines shall include the course duration, location, prerequisites, and a brief
   description of the subject matter.

1.9 GUARANTEE

A. Time Period

1. The Contractor shall guarantee all labor, workmanship, and materials for a period of one
   year from the date of final acceptance. Should a failure occur within the first year to the
   access control system, the Contractor shall provide all labor and materials necessary to
   restore the system to a complete operating condition, at no cost to the Owner.

1.10 SYSTEMS DESCRIPTION AND CAPABILITIES

A. Primary Function

1. The SMS’s primary functions shall be to regulate access through specific doors and gates
   to secured areas of the CUSTOMER’s facility and to provide digital CCTV recording
   capability to view live and recorded video that is associated with an alarm event. The
   SMS shall utilize the existing servers and related software/database for its access control
   and existing photo imaging. Integration shall be provided using one operating
   environment. The SMS’s workstation environment shall be a Microsoft Windows
   2000/XP Workstation operating system. No alternates will be accepted.
2. The software architecture shall be object-oriented in design, a true 32-bit application suite
   utilizing Microsoft’s ActiveX, COM, DCOM and .NET technologies.
3. The SMS shall allow the configuration of the existing integrated workstations (which
   provides photo imaging, alarm and display monitoring, and digital video review—both
   recorded and live), existing photo imaging workstations, alarm and display workstations,
   and digital CCTV recorders each with a capacity of up to 32 cameras. These
   workstations, file server(s) and Intelligent Distributed Network Controllers (IDNCs) shall
   be connected via the CUSTOMER’s high-speed IEEE 802.3 Ethernet backbone running
   the TCP/IP protocol. Up to 4 million nodes, i.e., workstations, servers, and IDNCs can be
   connected to this backbone.
4. The SMS shall be expandable to include, as a minimum, 256 photo imaging and/or 256
   alarm and display or integrated workstations.
5. The SMS shall support multiple communication ports including a communications
   network from which up to 32 I/O modules connect.
6. The alarm monitoring and display workstation shall be able to monitor field hardware
   devices, such as card readers, controllers, and I/O modules. Administrative tasks, such as
   assigning security areas, schedules, report generation, displaying color graphic maps, etc.,
   shall be provided from any workstation on the network.
7. The existing photo imaging workstation serves as both the credential creation and data
   input workstation for the card holder management of the system. The new proposed SMS
   system must be compatible with the school districts existing photo imaging system and
   functions described in section 2.02 paragraph 1 through 13. The integrated workstation
   shall allow all the functions of both a photo imaging and an alarm and display monitoring
workstation. All the data shall reside on the existing the servers and shall be instantly accessible at every workstation connected to the network. This shall provide automatic change propagation to all workstations in the system.

8. The RemoteView software shall permit viewing of live and recorded video from multiple digital video recorders simultaneously. The RemoteView shall also allow users to perform remote configuration of the digital video recorder(s).

9. The SMS shall support remote workstation(s) connectivity to the SMS file server via Remote Web Access connection(s).

10. The SMS shall utilize a commercially available, Open DataBase Connectivity-compliant (ODBC), SQL open architecture relational database with flexible design allowing the integration into other data structures. This database shall handle the storage and retrieval of all card holder records information, images, system maps, reports, and screen designs. The database shall operate in a truly multitasking environment without degradation of system operation and be of a design that will handle the transaction loading placed on the system. The relational database shall support online backup, stored procedures with control logic, and server-based referential integrity.

B. System Design

1. The SMS shall be designed to perform a wide variety of features and functions. These system functions should be categorized into four primary “system components” which shall include:

   a. Access Control: The SMS’s primary purpose shall be to provide access control. The system shall be able to make access granted or denied decisions, define access privileges, and to set schedules and holiday groups. And through the use of application programming these inputs and outputs shall be capable of being linked at all field controllers for purposes of implementing system-wide control strategies. The system shall support features such as area control, anti-passback, dial-up field hardware communications, extended shunt time, and multiple-man rule.

   b. Alarm Management

   1) The SMS shall be used for alarm monitoring. A color graphic application shall allow a user to create or import customized color graphic maps of their facility and to attach alarm icons to those maps. Alarms are to be prioritized. A status window shall provide information about the specific alarm including date and time and location of the alarm. The SMS shall allow unique emergency instructions to be specified for each type of alarm. Output control operations shall be available to lock, unlock, or pulse control points or groups of points as a standard feature. A card holder call-up feature allows the quick search and display of images in the database. A user journal shall be available to log important daily events. An image comparison feature shall be provided for use in conjunction with a CCTV technology interface. The SMS shall allow up to four CCTV cameras connected to the network digital video recorder workstation(s) to be associated with any alarm device, physical or virtual. Upon activation of an alarm the SMS shall automatically permit an authorized user to query the pre- and post-video that was recorded and associated with the alarm from any of the associated camera(s).
c. EXISTING Card Holder Management and Enrollment SYSTEM

1) The SMS shall utilize the existing employee management system database residing on the district’s SMS servers with the access control system. This employee management functionality shall allow the enrollment of card holders into the database, capturing of images, and import/export employee data. This functionality shall also allow the user to assign or modify access privileges of a card holder.

2) Separate or additional card holder management and enrollment system are un-acceptable.

d. System Administration

1) System Administrative tasks such as defining workstation and user permissions, area access, schedules; generation of reports; displaying maps; etc. shall be available at any workstation on the network. System tape backup and remote diagnostics shall occur at the designated file server that provides the required hardware.

e. Visitor Management System (VMS): The SMS shall include VMS software driven visitor management and check-in system to include:

1) Control and monitor visitors entry and exit
2) Grant visitors card access via proximity, barcode, driver license, or magstrip
3) Print professional looking full color customize ID badges by visitor type
4) Keep visitor information confidential so others cannot see who else visited the school or who they visited
5) Identify and keep unwanted people from gaining entry via watch list feature
6) Enable employees to pre-register their visitors via the internet/intranet
7) Email notification of visitors arrival
8) One click Emergency Evacuation report provides a list of who is in the building now and email list to emergency response personnel
9) Generate a full range of reports and search data base and see who is in the building and why.

PART 2 - OPERATIONAL REQUIREMENTS

2.1 GENERAL

A. The design of the SMS shall include devices and equipment used to monitor and control access to restricted areas, detect and deny unauthorized entries within specific buildings or areas, annunciate alarms, generate reports, and be integrated with the existing districts SMS to provide one unified SMS of control and monitoring. The SMS shall also provide CCTV integration and allow easy retrieval of recorded video and viewing of live video. Once incorporated with the day-to-day operations of the designated facility, the SMS shall detect and deter unauthorized entry into restricted areas and permit integrated CCTV surveillance to permit viewing of recorded video associated with alarm events. The SMS is to be designed and configured to provide operational flexibility and reliable performance.
B. Functional Responsibilities:

1. CUSTOMER shall have the responsibility for managing and operating the system, as well as maintaining the graphical representations of the designated facility input into the system’s color graphics application. It shall be the responsibility of the CUSTOMER to enroll all personnel and capture the associated images.

C. Operational Concept:

1. The SMS shall consist of equipment and devices placed at predetermined locations to ensure that only card holders who are authorized to enter secured areas through certain doors or gates can do so. This shall be accomplished by means of a computer and electronic devices used in conjunction with door locks, gate systems, card readers, and/or CCTV camera(s).

2. When an employee is newly hired or is changing job responsibilities, a personnel form shall be available within the SMS application. This employee data screen shall contain, at a minimum, 128 data entry fields of information. The employee data screen shall allow for multiple pages of user information that can be inputted upon enrollment. Above and beyond the 64 fixed fields there shall also be 64 user-definable fields. These fields shall vary in character length as dictated by the system. Data fields shall be assigned as alphanumeric or numeric.

3. As a fundamental operation, the SMS shall provide an integrated link between the existing photo imaging and access control system functionality. This will allow specific information concerning personnel data to be automatically shared by utilizing a single database. Personnel data and images shall be enrolled and captured via the photo imaging application and access privileges shall be assigned via the access control application.

4. After the applicant’s picture is captured by the system, the photo image is to be printed on the badge and appear in a pre-defined format specified prior to the system installation.

2.2 SMS FEATURES

A. All SMS applications shall be easy, quick and efficient to use. The system shall combine keyboard and mouse operations with graphical presentations of onscreen information. Each application is to provide consistent user interfaces across all operations of the system. Standard terminology, practical methods of generating help options, and menus are also required. All routine information displayed and requiring input shall be in English language prose. No operation shall require the interpretation of machine code or the use of mnemonics.

B. Visitor Management System (VMS) shall allow the Owner to grant temporary card access (or barcode access) to certain visitors or contractors directly from the SVM visitor form on the SMS Workstation at the time of check-in. The SMS operator shall either loan the person a proximity card, or have our barcoded badge open a turnstile or door, or activate an elevator within 2 seconds of issuing credential. The VMS shall also have the ability to compare entered persons to various watch lists before granting credentials. The VMS shall support an Enterprise System and allow operators to assign specific access on a building by building basis. The VMS shall pull the list of current cardholders from the SMS database on hourly intervals to have the most current active lists at all times and pull that list on a building by building basis.
C. Access Control

1. Access Privileges:
   
a. All card holders shall have facility access based on privileges assigned by
   controlled area, time and date. For example, some badges shall only allow access
   to the facility on weekdays between 8:00 a.m. and 5:00 p.m., while others allow
   access on weekends between 1 p.m. to 5 p.m. and so on. These time zones for each
   day are to be pre-defined by CUSTOMER and shall be able to be modified quickly
   by authorized employees without vendor intervention. There shall be an unlimited
   number of user-definable access privileges.

2. Holidays:
   
a. The Holidays application shall allow the System Administrator to create holiday
   schedules that designate individual days as holidays, or special days to cover
   vacations, maintenance shutdowns, or other events, indefinitely into the future.
   Holidays or special days can signal that the system shall operate on a schedule
   different from the normal. Holiday schedules shall be capable of overriding normal
   schedules.

3. Time/Date:
   
a. The time and date of the system shall be set by the operating system of the client
   workstation. Dates for Daylight Savings Time shall automatically take effect.

4. Global Data Exchange and Operating Strategies:
   
a. The SMS shall provide global data exchange and operating strategies. The system
   shall allow any input point configured in the system (i.e., door tamper, duress, etc.)
   to permit activation of any control output point such as a relay(s) that opens a door
   and/or sounds an alarm. The logic shall be developed using an application
   programming language that shall be capable of incorporating other parameters
   such as date and time; it shall not be limited by a fixed numbers of rules, or the
   simple linking of inputs to outputs. The global operating strategies feature shall
   provide the ability to drive any system output or outputs from single or multiple
   inputs, access events, alarms, etc. Each output point shall be controllable by the
   system and be configurable individually for the following responses:

   1) Output relays (and groups) shall be capable of responding to:
      
      a) Input alarms from any I/O module or card reader point in the system,
         or any combination thereof.
      b) Access events.
      c) Date and time parameters.
      d) Commands from a user.

   2) Output relays (and groups) shall be capable of:
      
      a) Pulsing for a predetermined duration; duration shall be programmable
         for each relay individually.
b) “Following” any input point from any I/O module, or card reader input in the system (on with alarm, off when clear, or as required).

c) Locking On with alarm, requiring user intervention to reset the output relay.

d) The system shall permit output relays to be ordered on, off, pulsed or reset back to a default setting.

5. Shunt Time:

a. A Shunt Time feature shall be provided to allow users to program, at the door level, a length of time to hold a door open without creating an alarm condition at the monitoring workstation. The shunt time feature shall be usable by any card holder with an active badge and appropriate access rights. Valid open times shall range from 0-255 seconds. If the door fails to close prior to the expiration of the shunt period, a “door held open” alarm shall occur at the system’s monitoring workstation. If the door is closed prior to the expiration of the shunt period, the door position switch shall become active immediately, allowing a “door forced open” alarm to be annunciated in the event of an intrusion.

6. Area Control:

a. The SMS shall provide five area control features: hard anti-passback, soft anti-passback, timed anti-passback, multiple-man rule, and occupancy limit. Area control shall be a security method of preventing a person from passing their badge to another person for dual entry into a location utilizing one card.

1) Hard Anti-passback

a) The hard Anti-passback feature shall require that a badge always be used to enter and exit an area. The controlled areas shall have both entry and exit readers at all portals. Areas shall be logically defined under the SMS, and area control shall not be required at all areas of CUSTOMER facility to be utilized. The system shall allow supervisors whose cards are configured “VIP” to be exempt from this feature as configured by the System Administrator.

2) Soft Anti-passback

a) The soft anti-passback feature shall require that a badge be used to enter and exit an area, but access shall not be denied if the badge was not presented in the correct order. The system shall automatically generate an anti-passback violation event and can be trigger an alarm to be generated. The controlled areas shall have both entry and exit readers at all portals. When a card holder uses a card reader for entrance, and has not swiped out, an anti-passback alarm shall notify the user. Areas shall be logically defined under the SMS, and area control shall not be required at all areas of CUSTOMER facility to be utilized. The system shall allow supervisors whose cards are configured “VIP” to be exempt from this feature as configured by the System Administrator.
3) Timed Anti-passback
   a) This anti-passback feature shall allow the System Administrator to decide how long after a card holder has swiped will they have to wait before the same card will be accepted again at the same reader or globally at any other reader defined in the Area.

4) Multiple-man Rule
   a) Multiple-man rule shall be provided through application programming to restrict access to certain areas unless there is more than one card holder present. Individual exit shall be permitted until the required number of people to originally gain access is reached, at which point the Multiple-Man Rule applies for exiting.

5) Occupancy Limit
   a) Occupancy limit shall restrict the number of card holders that will be present in an area at any given time. The occupancy limit shall be able to be defined by the System Administrator for each controlled area. Each area for which occupancy limit is enabled shall be definable at all controlled areas equipped with entry and exit card readers.

7. Elevator Control:
   a. The SMS shall provide elevator control software that will permit the restriction of card holder access to floors while also allowing general access to other floors. The elevator control software shall allow the use of any card reader and all reader modes used on any other reader in the system. The reader mode shall be schedule controlled to allow visitor access during business hours, and create higher security levels after business hours. An elevator card reader shall be located in the elevator cab. The card reader shall be integrated to the elevator controller. The SMS shall also be capable of monitoring all floor buttons. After the passenger swipes a card, them shall be required to press the desired floor button. The SMS shall then validate this card holder as having privileges to travel to the floor, or not. Upon a successful validation, the elevator controller shall illuminate the floor button and energize the relay to enable the elevator cab to travel to that floor. If the card holder is not valid or does not have access to the floor selected, the system shall not illuminate the floor button nor energize any relay. The system shall be able to generate reports that date/time stamp these access transactions. Each personnel record shall provide an easy to use form to specify to which floors a person has access.

8. Dial-up Communications:
   a. The SMS shall offer dial-up communication from the SMS Workstation(s) to multiple remotely located Intelligent Distributed Network Controller(s) (IDNC) utilizing industry standard 56 Kbps Hayes Compatible Modems as a communications method. The system shall allow each serial port at all workstations to be equipped with modems for remote communications.
The SMS host shall initiate communications to the dial-up IDNCs on the following conditions:

1) Upon user request.
2) At configured intervals.
3) When access control configuration changes are made.
4) When changes in card holders are made affecting the remote field controllers.

b. The dial-up IDNCs shall initiate host communications on any of the following conditions:

1) At configured intervals.
2) When specific events occur on the field hardware.
3) When the event buffer reaches a configured percentage of capacity.
4) When specific event/alarm types occur (e.g., access denied).
5) Only one standard dial-up telephone line per remote site shall be required, regardless of the number of IDNCs and I/O modules that are located there. Systems that require multiple dial-up telephone lines for multi-panel remote sites shall not be acceptable.

9. Manual Control:

a. A user shall have the ability to easily dictate manual control of all output points connected to the system via color graphic maps. Control points are defined as any door strike or any other relay output point of an I/O module. The System Administrator shall have the option to group these outputs to simplify common output command procedures.

b. All system outputs shall be displayed upon command in a list window or graphic map. The list and commands shall be operational without interfering with alarm monitoring operations. If an output is ordered to a setting, and is also on time zone control, the last command shall always override. All manual control commands shall record into the activity log for viewing by any user given proper privileges to do so.

c. Manual control for doors, or any relay output, shall allow the user to disable the door/output (to not accept any cards), unlock the door/output (leaving the door strike unlocked), pulse the door/output open, or reset the door/output to a pre-defined default setting.

10. Arm/Disarm:

a. The user shall have the ability to determine the current status (armed or disarmed) as well as the current state (alarm/normal/fault) of an input point from an input listview at any time.

b. The user shall have a “Status” item in the list view. Both the current status and state shall be reflected by the color of the respective columns in the list view.

c. Arm-Disarm shall be accomplished by a user through a simple click of the mouse on the individual point. Once a user arms an input point, events from the respective area permit the display of alarms at an alarm monitoring workstation from that point forward.

d. All input points shall be grouped for ease of operation into arm-disarm groups.
e. Arm-Disarm list views shall be viewable at any time.

D. Alarm Management

1. General:

a. The software shall be capable of accepting alarms directly from controllers, or generating alarms based on polling of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) shall be integrated into the overall alarm management system and shall appear in all standard alarm reports, be available for user acknowledgment, and have the option for displaying graphics, or reports. Alarm management features shall include:

1) A minimum of 255-alarm notification levels. Each notification level shall establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard annunciation, alarm printout, and record keeping.
2) Automatic logging in the database of the alarm message, point name, point value, connected controller, timestamp, username, time of acknowledgement, and time of alarm silence (soft acknowledgement).
3) Automatic printing of the alarm information or alarm report to an alarm printer or report printer.
4) Sounding of an audible beep or playing an audio (.wav) or displaying a video (.avi) file on alarm initiation or return to normal.
5) Sending an e-mail alphanumeric page to anyone listed in a workstation’s e-mail account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because a user has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize e-mail and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system’s mail application interface (MAPI). No special software interfaces shall be required.
6) Sending a text message to an alphanumeric pager compliant with the TAPI protocol.
7) Individual alarms shall be able to be re-routed to a workstation or workstations at user-specified times and dates. For example, an invalid card read alarm can be configured to be routed to a system administrator workstation during normal working hours (7 a.m.-6 p.m., Mon-Fri) and to a Central Alarming workstation at all other times.
8) An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes. As a minimum, the alarm viewer shall display:

   a) Date and time of alarm
   b) Name of alarm
   c) Priority of alarm
   d) Type of alarm
   e) Alarm message
   f) User text input
   g) User action drop-down list
   h) Acknowledged by
2. The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.

3. The active alarm viewer shall be configured for critical alarms such that a user is required to type in text in an alarm entry field and/or pick from the user action drop-down list. This ensures accountability (audit trail) for the response to critical alarms.

4. The user shall have the ability to Soft Acknowledge (i.e., Silence) or Acknowledge the alarm. Each of these actions shall be logged and date/time stamped.

5. Each alarm shall be configured to be acknowledged under the following:
   a. Acknowledge all of the same alarm type.
   b. Acknowledge all of the same alarm types until a specified time.
   c. Acknowledge only highlighted alarm.

6. The user shall have the ability to configure how alarms are removed from the active alarm view based on:
   a. Acknowledged
   b. Returned to normal
   c. Acknowledged or returned to normal
   d. Acknowledged and returned to normal
   e. Acknowledged after returned to normal

7. The user shall have the ability to highlight a specific alarm and select a button to display an associated graphic map, or select a button to display an associated report.

8. Each alarm event shall be configured as either Single Entry or Multi-entry. Alarm events that occur for the same point going into and out of the active alarm state may be designated as Single Entry and displayed in the active alarm view once only. Each time the alarm occurs, the time/date stamp of the single entry shall update in the active alarm view. In addition, each individual alarm event shall be logged into history with all respective times of occurrence. Alarm events designated as Multi-entry shall be shown in the active alarm view and in the alarm history log for each occurrence.

9. When an alarm is acknowledged, the system shall request a User Name, Password and Operator text description to be entered.

10. Other alarms shall be displayed by the system while any alarm is being addressed. If another alarm occurs, the alarm pending counter shall increase by one, the new alarm shall enter into the alarm list box prioritized in an order as defined by the System Administrator.

11. The SMS shall allow journals to be retrieved, viewed, and edited onscreen. Journals shall be saved to tape during tape backups for a permanent record as required by CUSTOMER regulations.

12. Current Status Indication
   a. The active alarm view shall provide a status indicator that displays the current status of alarms and field controllers. Selecting the graphic icon shall provide the
user with a detailed list of the groups of devices offering a dynamic list view of the current status of the respective points.

13. Card Holder Record Call-up
   a. The user shall be able to initiate the call-up of a card holder record. This feature shall be provided at all Alarm and Display Monitoring Workstations to assist the user in determining access rights for an employee who may have forgotten their badge.
   b. Utilizing a database search via the input of the card holder’s name, or other key search fields, the SMS shall access the employee’s personnel file, containing pertinent information and the employee’s image for identification by the user. This operation shall not restrict the operation of monitoring alarms.

14. CCTV Video Integration
   a. Activation of an alarm point, physical or virtual, shall automatically spawn the alarm video window to allow an authorized user to view the live video associated with the alarm area, as well as the pre- and post-video that had been recorded and associated with the alarm. Up to four cameras may be associated with each alarm point. A user shall also be able to query past video using date/time parameters and alarm device names.

15. CCTV/Image Comparison
   a. The recall of photo images taken by the SMS may be displayed in response to a card read alarm (e.g., access denied out of time zone, no access to area, badge voided, etc.), or any condition for that matter, at any user workstation. This is accomplished by selecting the event desired and displaying the record of the card holder selected. An interface to the CCTV system shall permit the automatic call-up of a camera located near the card reader in alarm and display the live CCTV image on the workstation, or an adjacent video monitor for user comparison of the images. This shall allow immediate user comparison of the card holder at the reader and the image on record for the card number.
   b. The user shall have the option to pulse the door open for the card holder from this window.
   c. The CCTV image shall be printable from the image comparison screen, if the monitor is equipped with a thermal video printer or a laser printer.

16. Automatic User Logoff
   a. The system shall automatically log the user out of the application after a specified period of inactivity. The user shall have to log back into the system to handle an alarm. This feature shall be configurable on a user by user basis by the system administrator.

17. Scheduling
   a. Time of day schedules shall be in a calendar style and shall be programmable up to 10 years in advance. Each standard day of the week and user-defined day types shall be able to be associated with a color so that when the schedule is viewed it is...
very easy, at-a-glance, to determine the schedule for a particular day even from the yearly view. To change the schedule for a particular day, a user shall simply click on the day and then click on the day type.

b. Each schedule shall appear on the screen viewable as an entire year, month, week, and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.

c. Schedules shall be assigned to specific controllers and stored in their local RAM memory. Any changes made at a workstation shall be automatically updated to the corresponding schedule in the controller.

d. Schedules shall be downloaded to the respective controller on a weekly basis.

E. Existing Card Holder Management and Enrollment

1. The SMS shall incorporate into a single, integrated system the latest in imaging technology and identification management database residing on the districts servers. The SMS shall generate and store up to four million personnel records, and monitor badge/credential use throughout the facility. These credentials shall be based on data and images that are input and captured at the time of enrollment and fabricated at any of the SMS photo imaging workstations. Credential images are to be digitized using industry standard JPEG image compression, and printed using a dye-sublimation/resin thermal transfer printing process that is high quality and environmentally safe.

2. Create and Maintain Personnel Database

a. The user shall be able to create personnel records either through the use of templates (as described in System Administration section), or direct input into the personnel record. Each personnel record shall allow for easy navigation through the fields. The user shall have the ability from the personnel record to easily:

1) Enable or disable the cards.
2) Define expiration date.
3) Define the acceptable card type.
4) Define the card number, site code and PIN.
5) Mark the card as lost.
6) Issue temporary or restore permanent card.
7) Display the employee photo image and/or signature.
8) Have the ability create or edit the image.
9) Create, edit, or delete the card holder’s access privileges and additional personnel attributes.

b. The selection of card type shall be chosen from a drop-down list that shall include ABA formats, Wiegand formats, and custom Wiegand format to allow use of a CUSTOMER’s existing cards that may be of a format not standard within the SMS.

c. The expiration date shall be determined by date and time of day carried out to the nearest second.
d. The user shall be able to mark the card as lost by selecting that control button. This shall disable the card and create a stored record with the associated card number and card holder. A new record shall automatically be created allowing the user to only have to add the new card number. In the event an attempted use of the card occurs, an invalid card event shall be logged and an associated alarm can be generated to an operator workstation.

e. The user shall be able to issue a temporary card by selecting that control button. This action shall temporarily store the existing card number and allow the user to then simply enter into the record the temporary card number. Upon return of the temporary card, the user shall select the reissue permanent card control button, which shall automatically restore the original card number.

3. Assigning Access Privileges

a. After a badge is created it shall be possible to assign access privileges to the personnel record. For convenience, the System Administrator shall be able to define default templates for given personnel types. If a user has proper authorization, access privileges can be overwritten. When an individual’s access privileges are modified, that change shall automatically be propagated to all required controllers immediately upon completion of the change. Record changes of access privileges shall affect only the modified record, and shall not require a download of the entire card holder database. Using personnel record configuration templates, the SMS System Administrator shall be capable of attaching previously defined privileges attached to the templates to new personnel requiring similar privileges. It shall be possible for the System Administrator to individually access the newly created personnel record to modify the privileges in the event the person does not exactly comply with the template.

4. Badge Creation

a. Image Capture

1) Existing SMS photo imaging workstation includes all equipment required to capture a high quality portrait image, with flash lighting and a high quality RGB digital video camera. The photo imaging workstation shall allow the camera user to view a live video image of the subject on the screen. The user shall view the subject in an upright position as they are captured.

b. While capturing subjects, the user shall have the option of capturing a new image of any subject without affecting the subject’s record. The photo imaging workstation provides a digitizer color control window in order to adjust the contrast and brightness of images. For convenience, default settings shall be provided.

5. The system shall provide the ability to move via mouse a “capture window” over any portion of the live image displayed on the monitor and store only the image information within the outline of the window. The SMS shall include the ability, upon command, to preview, online and in full color, the badge as it will appear when printed. This preview mode shall require less than 10 seconds to create a complete example of the badge online.

6. SMS image capture, storage, and hardware compression techniques shall be in compliance with the ANSI X3L2.8 standard or JPEG.
7. **Pre-defined Badge Formats**
   a. The badge format, including background color, layout, location of photo image, applicable graphics or company logos, text, etc., shall be completely and automatically determined by the system based on employee record information. Where choices are available to the user, choices are to be made via pre-defined list boxes to avoid user errors in spelling and badge assignment errors.

8. **Multiple Badge Formats/Badge Layout Services**
   a. The successful vendor shall provide services for creating badge layouts based on this specification. A single badge layout shall be provided with the system. Additional badge layouts and logos shall be available through the vendor if required. The screen design and database configuration shall be done in conjunction with the badge layout design.

9. **Existing Color Credential/Badge Printing**
   a. Credential printers are high-density dye-sublimation type printers offering, a minimum of 300 dots per inch resolution with a clear overlay option for high durability. The credential media used shall be compatible with the credential printer. The credential printer shall be able to print one-sided or two-sided credentials in credit card sizes and in portrait or landscape orientations.
   b. The user shall be able to print the badge as soon as it is created or to send the badge to a print queue for later batch printing. Within the print queue the user may print all badges, print a selected badge, and delete a selected badge or preview without printing.
   c. The credential printer shall incorporate a card cleaning system that cleans the front and back of the card simultaneously before printing begins.

10. **Batch Printing**
    a. The CUSTOMER photo imaging user shall be able to print a credential immediately or send it to a print queue. The SMS photo imaging workstation shall have the ability to print a large volume of badges with a single command using a print queue screen. At the print queue, the user shall have the option of printing all badges, printing selected badges, deleting a badge, or previewing badges without printing.

11. **Security Color Levels**
    a. The SMS shall be able to print badges with varying, user-defined security color levels created from the entire RGB spectrum. For example, a blue background badge may designate SECURITY, a orange background badge may designate EMPLOYEE, a red background badge may designate VENDOR, and a green background badge may designate ESCORT REQUIRED.

12. **Online Magnetic Stripe Encoding**
a. Utilizing a magnetic stripe encoder device, the existing SMS allows for magnetic stripe encoding of all its permanent credentials. This magnetic stripe shall conform to ABA Track II and ANSI specifications. Track II has a recording density of 75 bits per inch and five bits per character that results in 40 numeric characters including start sentinel, end sentinel and longitudinal redundancy check character.

b. The user may select a badge for encoding or delete a selected badge. Encoding and verification of the badge is performed on-line.

13. Search Records

a. The SMS shall allow the user to search for records and images using search criteria on any field(s) in the database. The user shall be able to enter the search criteria for one or a combination of fields.

F. System Administration

1. General

a. The workstation software shall use a familiar Windows Explorer-style interface for a user or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy-to-understand structure. The configuration interface shall also include support for template objects. These template objects shall be used as building blocks for the creation of the SMS database. The types of template objects supported shall include all data point types (input, output, string variables, etc.), personnel records, doors, alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of template object types shall be able to be set up as template subsystems and systems. The template system shall prompt for data entry if necessary. The template system shall maintain a link to all “child” objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants to update all of child objects with the change. This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the SMS.

b. All object names shall be alphanumeric and use Windows-type long filename conventions. The SMS shall allow all objects (door, personnel record, alarm, etc.) to be created with a unique 128-character name to provide the user with a fully descriptive object identifier. The system shall automatically create up to a 16-character alias from the object name to simplify the object’s use in reports, applications programs, and alarms, for example.

G. Workstation and Password Privileges

1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by, and only editable by, a system administrator. These sets of capabilities shall range from view only, acknowledge alarms, enable/disable, change values, program, and administrate. The system shall allow the above capabilities to be applied independently to each class of object. The system shall allow an unlimited number of users to be configured per workstation.
2. The SMS shall allow the system administrator to configure each workstation with those functions that may be performed at that workstation. Individual user passwords shall also further restrict user functions and shall be specific to each user. Specific user restrictions shall include:

   a. Access to screens or functions (e.g., alarm monitoring, badge issue)
   b. Specific tasks allowed (e.g., modify data, view only)
   c. Alarm monitoring functions (e.g., clear alarms, output control, traces, reports, arm-disarm)

3. If a user is denied access to specific functions, those functions shall dimmed on the user’s workstations or the status bar shall indicate “access denied” while that user password is logged in.

4. Once the System Administrator assigns a password, the user shall not have access to change his password. Passwords shall not print for any report.

5. The workstation privileges shall be those functions that are common to the user’s password and the workstation logged into. The SMS shall support individual password restrictions for each user.

H. Create and Maintain Door Objects

1. Door objects shall be created either through the use of templates (as described in section 2.2.4.1) or by direct input by the user. The door object editor shall be organized with tabs for easy navigation through the attribute fields.

2. From the door record the user shall be able to:

   a. Document a description of the door
   b. View and/or change the door’s current state from unlocked to locked and vice-versa
   c. View the state of the door switch
   d. Enable or disable the door state
   e. Specify up to four acceptable site codes
   f. Designate a general PIN
   g. Choose between Wiegand or ABA card type and select the appropriate bit format
   h. Associate door hardware wiring to the appropriate input/output channels
   i. Attach specific door unlock and door lock schedules
   j. Define anti-passback rules
   k. Define readers and attach associated controlled areas
   l. View a dynamically updated list of the last 25 events associated with the door

I. User Activity Logging

1. The SMS shall provide full user activity tracking. The activity log shall be comprehensive, recording the date and time of the activity, the workstation where the activity was performed, and the user that performed the activity. The SMS shall record changes to the database made by any user. Users shall be prompted to enter a user name, password, and explanatory text before any change or command is made to the system. Changes shall include setpoint changes, point edits, commands from a graphic panel, schedule changes, etc. This additional information is saved in the activity log for future reporting. Users shall be able to maintain their own passwords.
and the system shall automatically prompt the user to change their password on periodic basis.

2. SMS shall log over 200 separate functions, including:
   b. Additions, changes, and deletions to existing card holder management.
   c. Temporary pass add and delete.
   d. Other critical database functions.

3. SMS shall log changes made to the access control configurations:
   a. Changes to access privileges.
   b. Holidays.
   c. Time zone changes.
   d. Other critical items.

4. SMS shall log all of the district wide SMS activity including alarms, alarms acknowledged, cleared, output control activity, trace, and other functions. The SMS shall log a minimum of 1,000,000 events before the system history overwrites the oldest data.

5. The SMS shall provide a user activity report to query this information available in the SMS activity log. The report shall be sorted by existing host SMS workstation, user, date and time, or other selection criteria. On those occasions when historical data shall be needed, the user activity report shall be generated from an archived log as well as from the active existing SMS database.

J. Screen Format Design

1. The SMS shall allow a System Administrator to customize the employee record containing employee data. Additional data fields shall be definable in the database. Eighty user-defined data fields shall be available.

K. Integrated Development Environment

1. Each Alarm, Display, and Integrated workstation shall be equipped with an integrated development environment (IDE) to allow users the ability to write, edit, and de-bug the application programs resident in the Intelligent Distributed Network Controllers (IDNC). The IDE shall allow the display of multiple windows of application programs so users can quickly and easily “copy and paste” programming code using simple mouse clicks from one to another. The IDE shall also provide a tool set to allow users to quickly access libraries of commonly used object names, functions, values, and application programming keywords. Use of an IDE wizard shall permit use of pre-written application programs and creation of new programs that prompt for key values and create the program code automatically.

L. Reports

1. The SMS shall have the capability to provide as a minimum, the following standard reports:
a. User Activity Log  
b. Alarm History Log  
c. Door Status Report  
d. Alarm Point Status Report  
e. Controller Status Report  
f. Workstation Status Report  
g. Event History Log  
h. Invalid Attempt Log  
i. Valid Access Log  
j. All Personnel Report  
k. Disabled Personnel Report  
l. Personnel by Department Report  
m. Personnel by Area Privileges Report  
n. Lost Card Report  
o. Input/Output Status Report  
p. Schedules Report  
q. Company Listing Report  
r. Termination Report  
s. Badge Pending Expiration Report  
t. Cards Not Used in $x$ days (Deadbeat Report)  
u. All Doors Report  
v. All Events Sorted by Door  
w. All Events Sorted by Person  

2. Note: Each report shall print the date and time that the report was run. Reports shall be viewed on the screen when the report is run and the data has been compiled.

M. Custom Report Generation

1. The software shall contain a built-in custom report generator, featuring word processing tools for the creation of custom reports. These custom reports shall be able to be set up to automatically run or be generated on demand. Reports can be of any length and contain any point attributes from any controller on the district wide SMS network.

2. The report generator shall have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.

3. It shall be possible to run other executable programs whenever a report is initiated.

4. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

5. The software shall allow the simple configuration of row/column (spreadsheet-style) reports on any class of object in the system. These reports shall be user-configurable and shall be able to extract live (controller) data and/or data from the database. The user shall be able to setup each report to display in any text font, color, and background color. In addition the report shall be able to be configured to filter data, sort data, and highlight data which meets user-defined criteria.

N. HTML Reporting
1. The above spreadsheet-style reports shall be able to be run to an HTML template file. This feature shall create an HTML “results” file in the directory of the HTML template. This directory can be shared with other computer users, which shall allow those users with access to the directory to “point” their web browser at the file and view the report.

2. Access privileges shall be provided to allow the user the privilege of creating, deleting, updating, saving, processing, viewing, and printing reports. The reports are to be printed on a dot matrix printer or on a laser printer. Once a report is developed and saved, the user shall have the option to permanently incorporate the report into the system’s application by compiling the report definition into a report list available to any system workstation. The database report configurator shall be an option available for any workstation.

O. System Backup

1. A mandatory requirement, the SMS shall provide backup and restore programs utilizing the multi-tasking capabilities of the SMS which run concurrent with any other application of the system and in no way inhibit other use of the terminal. Database backup shall occur dynamically while other alarm monitoring, photo imaging, and/or access control applications remain active.

2. The number of active events to be stored shall be user-definable. If the event log is filled to capacity before an archive backup is done, the system shall start to overwrite the oldest events to make room for the newer events (FIFO). The following functions are required for the tape backup procedure of the system application:
   a. Archive Information:
      1) This function shall indicate how many days worth of event history is maintained on the system.
   b. Warnings:
      1) The SMS shall provide a configurable warning to allow a System Administrator to enable and define automatic system warnings. These warnings are to be sent to all currently active alarm monitoring workstations to notify the users when the event log is starting to get full.
   c. Capacity:
      1) The event queue storage capacity shall be displayed as a number up to eight digits long that shall specify the number of event records that can be stored on the system. This number shall be determined by the size of the fixed disk drive installed and is to be generated by the system’s database.

P. Color Graphic Map Configuration

1. The SMS system provider shall seamlessly integrate the SMS graphics into the district’s existing SMS software graphic package installed on the SMS Servers and have the ability to draw, edit, and copy site color graphic maps using any third-party
system software. At a minimum the map configuration software shall import map
drawings from the following formats:

a. PC Paintbrush (.pcx)
b. TIFF (.tif)
c. Lotus PIC (.pic)
d. Graphics Metafile (.cgm)
e. Targa (.tga)
f. JPEG (.jpg)
g. MACINTOSH Pict 2 (.pct)
h. Windows Bitmap (.bmp)
i. AutoCAD (.dwg)

2. These architectural-type maps shall allow the detailed layout of an entire structure,
part of a structure, a floor or department within a building, or layout the periphery
of a facility. Overview maps of an entire facility or campus shall be viewable as
requested, or a specific entry point of a facility can be accessed via graphic panel
objects that shall be able to be configured with multiple “tabbed” pages allowing a
user to quickly view individual graphics of equipment, which make up a subsystem
or system. Once a map has been drawn, the user shall have the ability to place
system level icons of card readers and input points in the appropriate area to
indicate their respective location on the map. This is to be accomplished by simply
dragging the icon with the mouse to the appropriate location on the map. The SMS
shall permit use of OCXs, and a full library of these controls including knobs, dials,
gauges, switches, peripheral devices such as lights, motion detectors, doors, etc.,
shall be provided as part of the SMS software. The system shall allow various maps
to be associated with each area to provide for the creation of a hierarchy of maps.
The SMS shall support graphic maps having a resolution of 1024×768 pixels.

3. As a minimum the SMS contractor shall provide graphic pages for CCTV, Click on
floor plan to bring up any CCTV camera. Live video from that camera shall be
displayed. Every camera shall be able to be displayed from any graphic page.
Access Control, Click on floor plan to bring up any door. Door plans shall show all
the door parameters. For a typical door shall be graphic showing a door with all its
associated devices. Each door will be required to have its own graphic page.

Q. Remote System Support

1. The SMS shall include remote system support from the system manufacturer and/or
local support dealer through remote diagnostics equipment that shall be included in
at least one system Workstation. The capabilities to be provided shall allow a
remote technical assistance center to analyze and perform any system diagnostic
function using a modem and PC Anywhere remote communications software, or an
approved equal, to allow support personnel to troubleshoot and correct problems via
a standard dial-up phone line. At a minimum a 28,800 baud modem shall be
provided for a serial port at a system Workstation on the SMS.

2.3 SMS DATA EXCHANGE

A. Data Import/Export
1. The SMS shall provide a function that shall allow the end user, and/or Contractor, to create, import, and/or export scripts to/from the SMS. The SMS shall permit the unsolicited receipt of personnel files from third-party systems such as the human resource (HR) system on an ongoing basis.

2. Flexibility shall be inherent in this utility; the automated import process shall include “insert record,” “update record,” “update/insert record,” and “delete record” (i.e., the assignment of access privileges). This utility shall allow the export of SMS records into customer-defined formats for use in external applications and systems. This utility shall allow the user to specify options, including files, fields, delimiters and/or fixed field lengths, formats, import/export mode, rules, and criteria. The user shall be able to indicate where the import or export file shall be located; on a floppy disk drive or hard disk drive. Once these ASCII-based files are received the SMS shall import automatically these records into the database without requiring user interaction. The SMS shall support a wide variety of formats for these personnel files. An application program within the SMS shall continuously query any shared resource on the network to which the HR generated file is to be written; and once a file is detected, the program shall initiate the reload of this file into the database using OLE servers at a user workstation. Records shall be capable of being added, deleted, and modified from the SMS database using this procedure. The SMS shall delete the HR file written to the shared resource immediately upon its import into the database.

2.4 MANUFACTURERS

A. Equipment in this Specification is based on products manufactured by Schneider Electric Andover SMS and other specific manufacturers, and is intended as the standard equipment to be furnished, or as approved. All manufacturers’ published specifications pertaining to this specialization shall have the same force and effect as if shown here in full.

B. The equipment supplier shall be Schneider Electric Andover Continuum furnished by;

   1. CS&E, Mike Brusco, 412-821-8900
   2. Roth Brothers, Kevin Callahan, 330-270-2543
   3. FIT, 412-367-6060

C. The Visitor Management System shall be Easy Lobby (Secure Visitor Management) software.

2.5 SYSTEM DESCRIPTION

A. The web-based Integrated Building Automation System shall encompass the electronic access control, security system, lighting control system, video surveillance and recording system. The SMS shall be controlled through a single graphical, web-based operator interface that allows for instant access to any sub-system through a standard browser. Systems requiring two or more different PC workstations are unacceptable.

B. The Owner shall provide all private and public telephone lies, ISDN lines and Internet Service Provider services and connections as necessary for the Contractor to complete the work as contracted at the Owner’s direct cost. The SMS Subcontractor shall identify the specific requirements in a shop drawing submittal.
C. Access Control – The system shall be able to make access granted or denied decisions, define access privileges, and to set schedules and holiday groups. And through the use of application programming these inputs and outputs shall be capable of being linked at all field controllers for purposes of implementing system-wide control strategies. The system shall support features such as area control, anti-passback, dial-up field hardware communications, extended shunt time, time and attendance, and multiple-man rule.

D. Card Holder Management and Enrollment: The SMS contractor shall furnish 500 blank cards as presently used by the school district.

E. Digital Video Management (CCTV) – The system shall monitor and record video images from analog cameras provided under this scope of work. Provide cameras as indicated on the drawings. The viewing of live and recorded video shall be possible from anywhere on the network, either from an SMS workstation, or from any PC connected onto the network, as permitted by the user’s password and privileges defined. Digital video shall be able to be linked to any alarm point, whether from the HVAC sub-system or card access/security sub-system, and shall be set up to display up to 4 specific cameras per alarm.

F. Smoke Management – When a fire alarm or early warning smoke detection alarm is triggered, the system shall perform all necessary fan shutdown procedures as appropriate for the site.

G. Elevator access controller, power supply, and card readers shall be a part of this contract and shall seamlessly integrate with the existing workstations.

H. For this project the system shall consist of the following top-level components:

1. Administration and Programming Workstation(s).
   a. The SMS contractor shall furnish 1 Operating Workstation (OW) Computer and printer. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the BOWS BACnet device profile. The workstations must communicate to the Network Controllers through Ethernet 10/100 mbps. Workstations that communicate using RS232 or RS 485/422 are unacceptable.

2. Web-Based Operator Workstations
   a. The SMS Subcontractor shall furnish licenses for 2 concurrent users to the SMS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. If required, a central web server shall be provided to manage the web-based users. The web-based interface must conform to the B-OWS BACnet device profile.

3. Ethernet-based Network Router and/or Controller(s).
   a. The SMS Subcontractor shall furnish Ethernet-based network controllers. These controllers will connect directly to the Operator Workstation over Ethernet, using the BACnet/IP protocol at a minimum of 100mbps, and provide communication to
the Standalone Digital Control Units and/or other Input/Output Modules. Network Controllers shall conform to BACnet device profile B-AAC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted.

b. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).

4. Digital Video Management Units. (NDVR)

a. The SMS contractor shall furnish 1 Ethernet-based Digital Video Recording units (NDVRs), capable of handling 32 cameras each, as described in Section 282300. These NDVRs will connect directly to the Operator Workstation over Ethernet, using the TCP/IP protocol at a minimum of 100mbps. The DVRs will respond to alarms from the HVAC controllers and access controllers, and start recording on the appropriate cameras for the alarm.

2.6 OPERATOR WORKSTATION REQUIREMENTS

A. General: SMS Subcontractor shall furnish and install a workstation utilizing the existing Andover software offering a fully integrated HVAC/Security solution and integrated with the existing districts Schneider Electric Andover CCTV, access control systems and the security database residing on the districts two servers. The new workstation shall consist of one (1) full-powered configuration and programming workstations, and one (1) web-based operator workstation. Consult with engineer for PC locations.

B. The programming and configuration workstation software shall be configurable as either a single workstation system (with a local database) or multi-workstation system where the database is located on a central file server. The client software on multi-workstation system shall access the file server database program via an Ethernet TCP/IP network running at 100MBPS.

C. The web-based user interface software must be capable of expansion up to 100 concurrent users.

D. All workstation software, both programming and web-based operator software, shall conform to the BACnet B-OWS device profile, using BACnet/IP to communicate to other BACnet devices.

E. All configuration workstations shall be Pentium 4-based personal computers operating under the Microsoft Windows XP operating system. The application software shall be capable of communication to all Network Router/Controllers and Standalone Digital Control Units, feature high-resolution color graphics, alarming, reporting, and be user configurable for all data collection and data presentation functions.

F. For multi-workstation systems, a minimum of 256 workstations shall be allowed on the Ethernet network along with the central file server. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations without the requirement for manual copying of files. Multi-workstation systems with no central database will not be acceptable. Multi-workstation systems with distributed/tiered file servers and a central (master) database will be acceptable.
G. Administration/Programming Workstation Minimum Hardware Requirements (Single workstation or multi-workstation configuration).

1. The workstation shall consist of the following:
   a. 3 GHz Pentium 4 processor with 1GB of RAM
   b. Microsoft Windows Seven operating system
   c. Serial port, parallel port, USB port
   d. 10/100MBPS Ethernet NIC
   e. 80 GB hard disk
   f. CD-RW drive
   g. High resolution (minimum 1280 x 1024), 17” flat panel TFT display
   h. Optical mouse and full function keyboard
   i. Audio sound card and speakers
   j. License agreement for all applicable software.

H. Web-Based Operator PC Requirements – Any user on the network can access the system, using the following software:

   1. Windows Seven /XP
   2. Internet Explorer 6.0 and above
   3. Java-enabled

I. Schedule of operator Workstations (OWS)

<table>
<thead>
<tr>
<th>ID</th>
<th>TYPE</th>
<th>LOCATION</th>
<th>PRIMARY FUNCTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>OWS1</td>
<td>Desktop PC</td>
<td>Security Office</td>
<td>Security/CCTV/Badging/Access Control, HVAC, High School, Edgeworth &amp; Osborne Elementary School, &amp; New QVMS SMS</td>
<td></td>
</tr>
<tr>
<td>PRT1</td>
<td>Inkjet</td>
<td>Security Office</td>
<td>New and Existing SMS Alarms</td>
<td></td>
</tr>
<tr>
<td>OWS 2</td>
<td>Desktop PC</td>
<td>Security Office</td>
<td>Badging System</td>
<td></td>
</tr>
<tr>
<td>OWS 3</td>
<td>Desktop PC</td>
<td>Security Office</td>
<td>Web Server</td>
<td></td>
</tr>
<tr>
<td>OWS 4</td>
<td>Desktop PC</td>
<td>Edgeworth Elementary</td>
<td>Security/CCTV/Badging/Access Control, HVAC, High School, Edgeworth &amp; Osborne Elementary School</td>
<td></td>
</tr>
<tr>
<td>OWS 5</td>
<td>Existing</td>
<td>Osborne Elementary School</td>
<td>Security/CCTV/Badging/Access Control, HVAC, High School, Edgeworth &amp; Osborne Elementary School</td>
<td></td>
</tr>
<tr>
<td>OWS 6</td>
<td>Existing</td>
<td>High School</td>
<td>Security/CCTV/Badging/Access Control, HVAC, High School, Edgeworth &amp; Osborne Elementary School</td>
<td></td>
</tr>
</tbody>
</table>
J. Printer: Provide an alarm printer and a separate report/graphics printer. The alarm printer shall be an Epson Inkjet or equivalent and the report printer shall be a black-and-white HP LaserJet.

2.7 ADMINISTRATION AND PROGRAMMING WORKSTATION SOFTWARE

A. General Description

1. The software architecture must be object-oriented in design, a true 32-bit application suite utilizing Microsoft’s .NET technology, making it easy to fully utilize the power of the operating system to share, among applications (and therefore to the users of those applications), the wealth of data available from the SMS.

2. The workstation functions shall include monitoring and programming of all controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.

3. Programming of controllers shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

B. System Database

1. The files server database engine must be Microsoft SQL Server. This ODBC (Open Database Connectivity)-compliant database engine allows for an owner to write custom applications and/or reports which communicate directly with the database avoiding data transfer routines to update other applications. The system database shall contain all point configurations and programs in each of the controllers that have been assigned to the network. In addition, the database will contain all personnel files and images, workstation files including color graphic, alarm reports, text reports, historical data logs, schedules, and polling records.

C. User Interface

1. The SMS workstation software shall allow the creation of a custom, browser-style interface linked to the user that has logged into the workstation software. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows XP user security capabilities, will enable a system
administrator to setup workstation accounts that not only limit the capabilities of the user within the SMS software but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

D. User Security

1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. There shall be an inactivity timer adjustable in software that automatically logs off the current operator after the timer has expired. Provide automatic password aging. If enabled, each user will be forced to change his or her password after a specified time period. Also provide a system-wide, adjustable minimum password length.

E. Database Partitioning

1. Since the SMS combines many disciplines, the system must be able to logically partition its database by function, and must be able to limit each user’s privileges to a certain partition. For example, security guards must have access to the alarm viewer and graphics interface; they may not have access to HVAC objects, lighting objects, or the programming environment. HVAC users may have access to all HVAC graphics and setpoints, but may not have access to personnel records, doors, or access areas. This type of partitioning must be easy and intuitive to set up and administer.

F. Configuration Interface

1. The workstation software shall use a familiar Windows Explorer-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, personnel record, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.

2. The configuration interface shall also include support for template objects. These template objects shall be used as building blocks for the creation of the SMS database. The types of template objects supported shall include all data point types (input, output, setpoints, etc.), alarm algorithms, alarm notification objects, reports, graphics displays, schedules, personnel records and programs. Groups of template object types shall be able to be set up as template subsystems and systems. The template system shall prompt for data entry if necessary. The template system shall maintain a link to all “child” objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants...
to update all of the child objects with the change. This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the SMS.

2.8 COLOR GRAPHIC DISPLAYS

A. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change set points from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:

1. XGA, bit-mapped displays. The user shall have the ability to import AutoCAD generated picture files as background displays.
2. A built-in library of animated objects such as doors, fire alarms, dampers, fans, pumps, buttons, knobs, gauges, and graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels. Using the mouse, operators shall be able to adjust set points, unlock doors, start or stop equipment, modify PID loop parameters, or change schedules.
3. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
4. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
5. If separate, provide a copy of the full graphic editing software on each workstation.
6. Provide the ability to link to any video camera on the system by clicking on a camera icon on a graphical floor plan. When selected, live video from that camera will display immediately.

B. The system shall support an operator definable “default” system page. The default system page shall be displayed upon system startup, operator activity time-outs, and when the system is not in use. This default system page may be any one of the standard dynamic graphic pages or may be a custom display developed for this purpose. The operator shall be able to display their corporate logo, emergency information, an index of all graphic pages, etc. as the default system page.

C. SMS contractor shall build the following graphics screens, complete with all pertinent graphics points to include both the High School and Eden Hall Upper Elementary security system:

1. Digitized view of building with icons for each sub heading.
2. Time and event programming (showing floor plan with each area as different color).
3. Central equipment
4. Room data (floor plan)

   a. If required, click on floor plan to bring up any room. Room plans shall show all the rooms parameters. For a typical room shall be graphic showing a VAV box
with all its working parameters such as damper position, inlet air temperature, valve position, actual CFM, room set point, space temperature, CFM set point, and fan control. Each room will be required to have its own graphic page.

5. Access control
   a. Click on floor plan to bring up any door. Door plans shall show all the door parameters. For a typical door shall be graphic showing a door with all its associated devices. Each door will be required to have its own graphic page.

6. CCTV
   a. Click on floor plan to bring up any CCTV camera. Live video from that camera shall be displayed. Every camera shall be able to be displayed from any graphic page.

2.9 WEB-BASED OPERATOR SOFTWARE

   A. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network. Access to the system must be available from a connection over the Internet.

   B. Graphic Displays: The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser’s graphics shall support commands to change setpoints, unlock doors, enable/disable equipment and start/stop equipment. The graphic shall also be able to display live video from any camera on the system.

   C. Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a copy stored in the system database.

   D. Alarm Management: Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user’s password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement.

   E. Groups and Schedules: Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.

   F. Through the browser interface, operators must be able to change schedules – change start and stop times, and add new times to a schedule.

   G. Personnel Management: Through the browser interface, operators must be able to add access control personnel records, delete personnel records, add and remove area privileges, and view the stored image of the person.

   H. Video Management: Through the browser interface, operators must be able to view live and recorded video from any digital video recorder on the network. The interface must offer an easy
method to select the camera to view, and for recorded video, must offer selections for start and stop time when searching video clips.

I. Access Reports – Through the browser interface, operators must be able to create and view reports of access events and access privileges. Reports must be available based on start and stop time, door, area, and person. Invalid attempts must be color-coded red in the report. Provide hot links to the respective personnel records within the report.

J. History Reports: Through the web browser interface, operators must be able to call up graphical reports of historical values over time such as temperature, humidity and any other logged value in the system. The reporting function must also provide graphical reports for analysis of non-analog information such as the alarm log, event log and activity log – examples are a graph of the top 10 alarmed points over a certain period of time, traffic counts for each door over time, workstation activity displayed per workstation.

K. User Accounts and Audit Trail: The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.

L. All commands and user activity through the browser interface shall be recorded in the system’s activity log, which can be later searched and retrieved by user, date, or both.

2.10 CARD ACCESS PROXIMITY CARD READERS

A. SMS Subcontractor shall provide HID or Motorola Indala Proximity card readers or an approved equal. Each reader shall offer a low profile, rugged, weatherized polycarbonate sealed enclosure with multi-color LEDs and a sounder for access granted and denied indications. Each shall be mountable indoor or outdoor.

2.11 KEYPADS APPROVED FOR SMS (PROVDE WHERE REQUIRED)

A. Andover Continuum LD+, consist of 19 button backlit keypad, four line 16 character backlit LCD display, audible beeper, direct interface to the Andover Continuum SMS software.

B. Essex Electronics 12 Pad, Barantec, or approved equal. Keypads shall contain three columns by four rows containing the characters 0 through 9, the pound (#) and the star (*) sign. The keypads shall be suitable for either indoor or outdoor use.

2.12 POWER SUPPLIES FOR ACCESS CONTROLLERS AND READERS

A. Power supply to be modular construction with surface wall-mounted enclosure; 120 volt supply, adequate to serve control panel and remote readers. Include battery-operated emergency power supply with capacity (6 amp-hours minimum) for supporting system during power outage. Power supply equal to Altronix Model AL600ULM.

2.13 DOOR CONTACT/STATUS SWITCH

A. UL Listed
1. ¾” diameter recessed magnetic contacts with factory installed wire leads, minimum 1-foot long – 22AWG.
2. Self-lock mounting.
3. Installation shall include the application of mounting compound for added adhesive strength.
4. Where field conditions prohibit the use of a recessed magnetic contact, surface mounted switch shall be used.
5. Type: Delta Security Controls/Model #170-15 or equivalent/Model #189-15W or equivalent.

B. Overhead Door Magnetic Contact Switch

1. Unit shall be equipped with an armored cable and be of low profile design.
2. The unit shall have cast aluminum housing and be corrosion resistant.
3. Unit shall be Sentrol Model 2200 or equivalent.

C. Request to Exit Sensor

1. Manufacturer: BOSCH DS1501
3. Designed for ‘request-to-exit’ applications.
4. Detects motion in coverage area and signals an access control system or door control device.
5. Single or double door use.
6. Ceiling or wall mount.
7. Internal vertical pointability.
8. Wrap-around coverage pattern.
9. 12 or 24 AC or DC operation.
10. Up to 60 second adjustable latch time.
11. Selectable relay trigger mode.
12. Selectable fail safe/fail secure.
13. UL listed.
14. Locate exact location and aiming per manufacturer.

D. Request to Exit Sounder:

1. Manufacturer: Ademco 747 Series
2. 12 VDC.
3. Provide ceiling or wall mount at each request to exit sensor.

2.14 SMS PROXIMITY CARDS

A. Proximity shall be an access control/identification technology that utilizes radio frequency (RF) circuits in microchip form. The microchips are encoded and transmit the encoded information when activated.

B. The SMS shall be provided with the following proximity card design:

1. The proximity card shall be used with any of the listed proximity card readers. It shall be a polycarbonate-based card.
2. The proximity card shall be a PVC dual technology card that employs both proximity and magnetic stripe technology that shall allow the printing of card holder record fields directly on the card.
3. The proximity card shall be capable of allowing for direct printing of one surface using a dye-sublimation/resin thermal transfer printing process.
4. Contractor shall provide 500 cards.

2.15 SMS PVC CARD

A. The SMS shall utilize a credit card size (3.370" x 2.125" OD), or approved equal PVC (PVH or PVCH) card. The PVC cards shall be printed by placing them in the dye-sublimation/resin thermal transfer printer. Traditional paper media inserts shall not be acceptable. PVC shall allow a full-frontal print surface without edges, containing a ½" high-coercivity magnetic stripe placed to ANSI/ISO standards and bar code printable. It shall be difficult to alter, durable, consistent in shape and size, and flexible in design.

2.16 EXISTING BADGING SYSTEM

A. General PVC Card Printer Fargo DTC550– The contractor shall provide a high density dye-sublimation/resin thermal transfer type image printing system which prints two sides, edge to edge, directly onto a white unfinished 0.030 PVC, PVH or PVCH card at a rate of approximately 20 seconds per card. Provide one (1) spare DTC 550 Printer Ribbon.

B. The card media is to be fed to the printer automatically through a card hopper that shall accommodate 100 30-mil (0.030") thick cards. The IBAS shall download the badge layout directly to the printer and, using a dye diffusion thermal transfer process, print it directly onto the card. The dyes are to be embedded into the top layer of the card, making it difficult to permanently alter its appearance. The card production system shall also apply a clear ultraviolet security overprint to the entire printable area of the card. This overprint shall expose card tampering when viewed under reflected or ultraviolet light.

C. Web Camera Pro 9000- The contractor shall provide a Logitech Web Camera Pro 9000

D. Photo Imaging Workstation – The photo imaging workstation is a complete electronic photo ID computer workstation that creates high quality, tamper-resistant color credentials in a production environment. This workstation shall enroll card holders and maintain personnel information and images into the IBAS relational database. This information can be recalled at any time to modify existing records, verify employee status, or reissue new credentials.

E. The photo imaging workstation shall be the primary workstation for employee enrollment, badge production, and access privileges assignment to card holders. The photo imaging workstation shall consist of the same hardware as the alarm monitoring workstation, with the following exceptions:
   1. RGB video camera with flash lighting, stand and backdrop
   2. PCI video capture board for PC
   3. PVC card printer
   4. Continuum LAN-SEC-U-P- B-USB Software License with USB Key.
2.17 SPECIFIC CARD FEATURES

A. The identification card shall meet CUSTOMER requirements to incorporate multiple use and/or security features into one common credential. The following custom features shall be included:

1. Card shall be credit card size, 3.370" x 2.125" OD in a Portrait/Landscape format.
2. ½" Magnetic Stripe high-coercivity placed on the rear to ANSI/ISO standards.
3. The CUSTOMER logo shall be printed thermally on the Digital ID Printer on a portion of the card. The SMS shall generate and print logos.
4. A visible light bar code shall be included in the badge design offering the card holder’s employee number from the card holder record.
5. The following database fields shall print on the thermal media from the card holders database record:
   a. First Name
   b. Last Name
   c. Division/Department
   d. Expiration Date
   e. Card Number

6. A white rectangle signature panel shall be provided, located on the exterior of the back of the card. This panel shall accept a signature written with a pen.
7. Pre-printing shall be used on the backside to provide card return/issue information that shall be common to all cards produced.
8. Pre-printing shall include a three-color CUSTOMER logo.
9. A rendition of the required card is provided as an appendix. A sample card may be included with the Contractor proposal package.

2.18 AIPHONE AUDIO/VIDEO DOOR AND OFFICE STATIONS WITH HID READER

A. Door Station:

1. Stainless Steel Flush Mount
2. Wide Angle Digital PanTilt and Zoom
3. Vandal Resistant, Flush Mount
4. ¼" Color CMOS camera
5. Locator LED backlit on call button
6. LED illumination automatically turns on in low light
7. Wide angle camera views up to 170° of entire entry
8. Entry can be monitored without alerting visitors, day/night
9. Camera position and zoom can be set for call-in
10. Embedded HID ProxPoint plus Proximity card reader

B. Master Station JK-1MD

1. Master monitor, PanTilt & Zoom video entry 31/2” TTF LCD monitor
2. Picture memory records up to 240 images
3. Wide angle camera views up to 170° of entire entry
4. Backlight/night sensitivity adjustments
5. Monitors turns on when camera station calls in
6. Hands free (VOX) after talk button is pressed once, or push to talk  
7. Door release button & LED indicator  
8. *Requires MCWS-S/A mounting stand

2.19 AIPHONE AUDIO/VIDEO DOOR AND OFFICE STATIONS

A. Door Station

1. Aiphone vandal resistant type AX-DVF-HID flush mount /HID PROXPOINT Plus Reader.  
2. Video door station with color CCD camera.  
3. RY-18L Form Door release relay, 12-18V DC Input  
4. PS-1820UL 18V Power Supply, 2A UL Listed  
5. Infrared illumination for low light viewing (1 lux) - @ 12”  
6. Camera cover is Lexan® - flame and shatter resistant.  
7. Surface mounted back-box (existing doors if required)  
8. Faceplate constructed of 1/8” thick stainless steel.  
10. Calling: Chime or call tone heard at inside station.  
11. Monitor turns on when call button is pressed.  
12. Hands free communication at camera unit.

B. Master Station AX-8MV

1. Aiphone AX Audio/Video master, black, 8 Door & Master BTNS.  
2. AX/DVF-P Video Door Station w/Prox reader, flush mount.  
3. Connection for 7 door stations and 7 inside monitor stations Hands free communications, voice operated exchange (VOX).  
4. AX-248C main CEU for 24 doors, 8 Masters, AX  
5. PS-2420UL 24V DC Power Supply 2A UL Listed  
6. Press to talk can override VOX.  
7. White LED illuminator turns on in low light conditions.  
8. Door call-in LED lights in red or green.  
9. RY-18L Door release contact rating: 12-18V DC INPUT  
10. Additional door release buttons.

C. Master Station MCWS-S/A

1. Aiphone MCW-S/A.

2.20 PROJECT MANAGEMENT

A. Upon receipt of a purchase order, the Contractor shall assign the project to a specific project manager. Project managers are selected for their skills and experience in organizing complex, multifaceted projects. This will assure effective planning and communication among the numerous people whose efforts are coordinated during the life of the project. The project manager shall provide the following services:
1. Written and agreed project plans detailing the successful installation and acceptance of the system within specified time frames.
2. Coordination and scheduling of all Contractor deliverables through project completion including:
   a. Hardware and software configurations.
   b. Installation of equipment.
   c. User training.
   d. Documentation and specific project related requirements.
   e. Provide services or consultation for:
      f. Site preparation.
      g. Credential design.
      h. Screen layout design, formats.
      i. Database design/configuration.
      j. Data input options.
      k. System Administration.

B. Primary point of customer contact for all project communication from receipt of order through final system acceptance.
   1. Preparation of clearly defined project-specific system acceptance criteria.
   2. Appropriate status reporting, attendance at all project meetings.
   3. Formal commissioning of specific project documentation an as-built drawings to the CUSTOMER system administrator and maintenance contractor.
   4. Preparation of agreement for contractor continuing maintenance and schedule.

C. Installation of the SMS shall include the appropriate equipment and shall be performed by a factory-trained contractor installer. The installation shall be completed to these specifications and project plans as required by the CUSTOMER or prime Contractors. A comprehensive customer site-planning guide for the SMS shall be provided. Adherence to the specific requirements of this document will assist in ensuring a successful System installation. The installation shall include the following:

   1. Site planning and system configuration of field hardware and SMS.
   2. Complete hardware setup of all system Workstations and peripherals.
   3. Complete configuration of all system Workstations, peripherals and installation of field hardware.
   4. Setup of specific network software configuration requirements.
   5. Badge Design and Screen Format installation and verification.
   6. Complete system diagnostics verification.
   7. Complete system operation verification.
   8. Problem reporting and tracking.
   10. Completion of specific customer acceptance test plans.
   11. Formal turnover of the specific project installation documentation to Maintenance Service Organization.

D. NOTE: Regulated power shall be provided by CUSTOMER with dedicated circuits for the installed System. All circuit breakers shall be properly identified and equipped with a “lock” to prevent inadvertent actuation of the breaker.
PART 3 - IMPLEMENTATION

3.1 SCHEDULE

A. Required planning and coordination of numerous elements and deliverables during the installation and commissioning phases shall be handled professionally and within a specified schedule. This SMS project schedule shall resemble the outline below:

<table>
<thead>
<tr>
<th>Major Milestones/Tasks</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Start To Project Complete</td>
<td>120-180 days</td>
</tr>
<tr>
<td>System Riser Diagrams</td>
<td></td>
</tr>
<tr>
<td>System Detailed Installation Drawings</td>
<td></td>
</tr>
<tr>
<td>Award to Contractor</td>
<td></td>
</tr>
<tr>
<td>Review Project As Purchase Order Describes</td>
<td></td>
</tr>
<tr>
<td>Plan Specific Project Requirements</td>
<td></td>
</tr>
<tr>
<td>Define Installation Timeline, Tasks and Milestones</td>
<td></td>
</tr>
<tr>
<td>Agree on Project Plans with Customer</td>
<td></td>
</tr>
<tr>
<td>Intent to Proceed</td>
<td></td>
</tr>
<tr>
<td>Order System Components</td>
<td></td>
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<tr>
<td>System Components Order</td>
<td></td>
</tr>
<tr>
<td>Discuss Badge Layout Options</td>
<td></td>
</tr>
<tr>
<td>Credential Procurement Order</td>
<td></td>
</tr>
<tr>
<td>System Training Scheduled</td>
<td></td>
</tr>
<tr>
<td>Administration, User, Maintenance Training</td>
<td></td>
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<tr>
<td>CUSTOMER to Designate a System Administrator</td>
<td></td>
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<tr>
<td>System Components Delivery</td>
<td></td>
</tr>
<tr>
<td>Hardware &amp; Software, Consumables, Documentation</td>
<td></td>
</tr>
<tr>
<td>Develop Screen Layout Format</td>
<td></td>
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<tr>
<td>Submit Specific Acceptance Criteria Test Plan</td>
<td></td>
</tr>
<tr>
<td>Installation of SMS Components</td>
<td></td>
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<tr>
<td>Network</td>
<td></td>
</tr>
<tr>
<td>System Hardware</td>
<td></td>
</tr>
<tr>
<td>Optional Applications and accessories</td>
<td></td>
</tr>
<tr>
<td>Badge Customer Personnel</td>
<td></td>
</tr>
<tr>
<td>Test Complete System</td>
<td></td>
</tr>
<tr>
<td>Project Specific Acceptance Tests</td>
<td></td>
</tr>
<tr>
<td>On-line Operational System Test</td>
<td></td>
</tr>
<tr>
<td>Full System Acceptance</td>
<td></td>
</tr>
</tbody>
</table>

B. Milestone/Task duration’s are dependent upon contractual and system configuration/functionality requirements and assume all critical path tasks, as required by this schedule, are completed as scheduled by all parties involved.

3.2 FIELD QUALITY CONTROL

A. General

1. Quality control services include inspections and tests and related actions including reports, performed by independent government agencies, governing authorities, and
the Contractor. They do not include contract enforcement activities performed by the Engineer.

2. Inspection and testing services are required to verify compliance with the requirements specified or indicated. These services do not relieve the Contractor of responsibility for compliance with contract document requirements.

B. Quality Assurance

1. **Source Limitations:** To the fullest extent possible, provide products of the same kind, from a single source, and from the same manufacturer.

2. **Descriptive Specification Requirements:** Where specifications describe a product of assembly, listing exact characteristics required, with or without use of a brand or trade name, provide a product or assembly that provides the characteristics or otherwise complies with contract requirements.

3. **Performance Specification Requirements:** Where specifications require compliance with performance requirements, provide products that comply with these requirements, and are recommended by the manufacturer for the application indicated. General overall performance of a product is implied where the product is specified for a specific application.

C. Installation of Products

1. Comply with manufacturer’s instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

2. The Contractor is responsible to remedy defects due to faulty workmanship and materials that appear within one year from the date of acceptance in accordance with the General Conditions, unless Specifications sections specify a different duration.

3.3 SYSTEM ACCEPTANCE TEST

A. Phased Testing

1. A phased acceptance test and performance demonstration program shall be developed and documented by the Contractor under the direction of the SMS Systems Engineer. These requirements shall apply to all system components and software, including, but not limited to all system computers, field controllers, card reader devices, PIN pads, photo imaging system peripherals, CCTV cameras and equipment, and interface capability. The Contractor shall perform the tests and document the results under the supervision and witnessing of the SMS Systems Engineer. Operational scenarios shall be developed and used by the Contractor to simulate the actual use of the system in the normal environment of the CUSTOMER facility. The SMS Systems Engineer reserves the right to modify the Contractor’s plan or develop new operational test and evaluation procedures to effectively document system operations.

3.4 SYSTEM DOCUMENTATION
A. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, data sets, the hardware, and peripherals. All updates, addendum and adjustments to the documentation shall be provided at no additional charge, in the same quantities as originally required. Each division shall define the initial quantities.

3.5 SYSTEM ADMINISTRATOR MANUAL

A. Overview and step-by-step guide and instructions detailing all System Administrator responsibilities and authority.

3.6 USER MANUAL

A. Step-by-step guide and instructions detailing all system user functions and responsibilities.

B. Photo Imaging Users Manual

C. Step-by-step guide and instructions detailing all image capture, badge creation, card holder modification, and all photo imaging user functions and responsibilities.

3.7 ALARM MONITORING MANUAL

A. Step-by-step guide and instructions detailing all alarm monitoring system user functions and responsibilities.
3.8 TECHNICAL MAINTENANCE MANUAL

A. Shall be a comprehensive and detailed document providing all maintenance action, system testing schedules, troubleshooting flowcharts, functional system layout, and block and schematic diagrams of all system wiring.

3.9 SYSTEM TRAINING

A. Proposal shall include 24 hours of system training on-site by a representative of the SMS manufacturer. Training shall take place before the system is operational as described in the project schedule. A detailed description of the training material shall be included in the submittal package. All training courses shall enable the attendees to be capable of all normal system operations within their respective positions.

B. If an alternate Andover SMS contractor is selected other than the school districts existing Andover SMS representative, the alternate SMS system contractor shall provide an additional 48 hours of onsite training. This is required because of dissimilar operating systems and programming requirements. This additional training is equal to the training the owner has received on the existing Andover security system.

C. System Administrators shall receive a course detailing the system functions and operations. Course shall offer configuration training on all aspects of the system including data import-export, reports, card holder management, system workstations, peripherals and field hardware.

D. Photo imaging Users shall receive a course detailing the functions and operations of all aspects of credential production, image capture, card holder record management, reports and workstation peripherals which are part of the photo imaging process as it relates to integration of the new SMS system with the existing photo imaging card management system.

3.10 ALARM MONITORING USERS

A. The SMS contractor shall provide a detailed course detailing the operation of all aspects of alarm monitoring functions, reports, error messages, alarm handling, output relay control, and general overview of field hardware.

END OF SECTION 28 1300
SECTION 28 1600 - INTRUSION DETECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 28 Sections apply to this section:

C. Division 28 section 280100 “Basic Electronic Safety and Security Systems Requirements”.

D. Division 28 section 281300 “Access Control”

E. Division 28 sections 282300 “Video Surveillance”.

1.2 DESCRIPTION

A. Furnish and install a complete intrusion detection system with the performance criteria detailed in this specification. The system shall be inclusive of all necessary functionality, monitoring and control capability as detailed herein and as shown on the plans.

B. The system shall be completely programmable from any keypad with programming access determined by a level of Personal Identification Number (PIN) code. There shall be no need for a removable programming module of PROM burn to accomplish user-programming changes.

C. PIR Sensors: The Division 28 Security contractor shall provide all the required control wiring and control interlocking wiring as shown on the T-drawings. The SMS contractor shall include all cost associated for roof and pole mounting and required roof penetrations where required. The E.C. shall provide 110V power requirements. The new and existing Andover integrated security system software shall provide for intrusion alarms and notification generated by the PIR sensors. The integrated Andover SMS system to provide the required intrusion alarm output points to interface with a third party intrusion alarm and monitoring system.

D. Intrusion controllers, power supplies, passive infrared motion detectors, magnetic door contacts (required on all external doors where shown on T-Drawings) and alarm horns shall be a part of this Division and provided and installed by the division 28 security contractor.

E. The system supplier shall be a company specializing in the manufacture and supply of intrusion systems with at least (5) five years of experience and shall have local employees available for support during installation and for final hook-up and acceptance testing.

F. The catalog numbers specified herein are those of the Ademco Vista series and constitute the type, quality, required operating features and equipment to be furnished.
1.3 SYSTEM DESCRIPTION

A. Input/Output Capacity: The system shall be capable of monitoring 87 individual loops or zones and controlling a minimum of 16 output relays.

B. User/Authorization Level Capacity: The system shall be capable of operation by 75 unique PIN codes.

C. Operational Options:

1. All/Perimeter System: The user of the system shall be capable of arming and disarming all zones or all zones excluding those zones designated as interior zones.

2. Partitioning: The user of the system shall be capable of selectively arming and disarming any one or more of 8 areas within system based on the user P.I.N.code used. Each of the 87 loops or zones shall be assignable to any one of the 8 available partition areas.

D. Keypads: The system shall support a minimum of 15 keypads with Alphanumeric Displays. Each keypad shall be capable of arming and disarming any portion of the intrusion detection system. The keypads alphanumeric display shall provide complete prompt messages during all stages of operation and programming of the system and display all relevant operating and test data.

E. Loop Configuration: The system shall have a minimum of 9 Class B loops available in the control cabinet and support up to eleven (11) 8-input remote modules. All Class B loops shall be 2 wire, 18 AWG minimum, supervised by an End-Of-Line (EOL) device and shall be able to detect open, normal or short conditions in excess of 200 milliseconds duration.

F. Multiplex Communication: Communication between the control panel, all keypads and remote modules shall be multiplexed over a 4 conductor non-shielded cable. This cable shall also provide power to all keypads, remote modules and other power consuming detection devices.

G. History buffer: The Command Processor shall contain a 224 event history buffer which can be read at any keypad location. The event buffer shall log all open/close events, alarms and troubles by time and date.

H. Primary Power: The Command Processor primary power supply shall be a 16 VAC 100VA Wire-in transformer. Plug-in transformers are not acceptable.

I. Secondary Power: The command Processor secondary supply shall be 12VDC 6AH sealed, lead-acid, rechargeable battery. The battery shall be protected by an automatic circuit breaker. When initially connected to a battery power alone, the control panel shall be protected by a cutoff relay until manually started or primary power is applied. The secondary power shall be float charged at 13.8 VDC at a maximum of 1.2 amps.

J. Lighting Suppression: The control panel primary power source and incoming telephone lines shall be protected from lightning, power surges, voltage spikes, and transient or RF interference with a combination of zener overvoltage transient suppressors, R/C filters, ferrite beads and spark gaps.

K. Remote Communication Capacity: The system shall be monitored by an owner selected Central Monitoring Station using a Digital Alarm Communication Transmitter. The system shall be
capable of dialing 2 telephone numbers of 20 digits each using the switched telephone network such that if 2 unsuccessful attempts are made to the first number the system shall automatically switch to the second number and make 2 attempts. If these 2 attempts are unsuccessful the system shall switch between numbers after 2 attempts each, until a successful connection is made of a maximum of 10 tries are attempted. Once 10 unsuccessful attempts are made the system shall stop dialing. Should another event occur which requires a message to be transmitted the dialing process the dialing process shall be repeated.

L. Entry Delay: The system shall permit an entry delay time of (0 to 250) seconds on any loops assigned as exit type loops. When an armed exit type loop is activated, a prewarn tone shall sound and the entry keypad shall display "EnterCode". If a valid user code is not entered prior to the expiration of the entry delay, and alarm will be sounded.

M. Exit Delay: The system shall permit an exit delay time of (0 to 250) seconds on any loops assigned as exit loops. This exit delay shall be displayed and counted down on the exit keypads alphanumeric display. If any loop is in an alarm condition at the expiration of the exit delay, the entry delay sequence will commence immediately.

1.4 MANUFACTURERS

A. Equipment in these specifications has been taken from the catalogs of Ademco, as shown, and is intended to denote a standard of quality and type. All published specifications of the manufacturer shall be deemed as being a part of this specification section, and shall have the same force and effects as if written herewith in full. In order to guarantee the Owner of all factory warranties, all equipment shall be obtained from a local factory authorized vender/distributor for the jobsite geographical location.

B. The intent is to establish a standard of quality, function and/or features. It is the responsibility of the bidder to ensure that the proposed product meets or exceeds every standard set forth in these specifications.

C. The functions and features specified are vital to the operation of this facility; therefore, inclusion in the list of acceptable manufacturers does not release the contractor from strict compliance with the requirements of this specification.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Control Panel

1. Furnish and install where shown on the plans an Ademco Vista Model 50P Multiplex Control Panel. The unit shall be a user-friendly system that contains 8 protection loops in the control cabinet. It shall be capable of communicating with Addressable Initiating Devices and Remote Input Modules (each of which is capable of monitoring 8 protection loops). The system shall support up to fifteen remote keypads. The architecture shall allow the system to be configured either as a perimeter/interior system or as up to eight
separately controlled areas within one system. The system shall have provisions for up to 16 outputs and shall include a 7-day clock for time control of outputs.

B. Keypads: Furnish and install where shown on the plans 6139 Alphanumeric Keypads. The keypads shall provide plain English instructions for operating the Security System. The units shall include the pre-warn tone sounder.

C. Door monitor switches shall be model 4944SN flush mounted, wide gap style.

2.2 SECURITY HORNS

A. Unit shall be flush mounted and be able to mount to a standard 4” square electrical box.

B. Horn shall have high dG output.

C. Complete with basket and weatherproof surface back box.

D. Unit shall be rated for outdoor use.

E. Horn shall be manufactured by Edwards Signal Systems and Series 868 or equivalent

2.3 Outdoor PIR Sensor

A. Manufacture: OPTEX AX-200TN or APPROVED EQUAL

1. Anti-Frost Hood Cover
2. Twin Beams requires simultaneous to create activation
3. 99.5% beam blocking stability
4. Adjustable beam interruption
5. IP65 durability
6. CCTV solutions
7. Operating temperature (-31°F to +140°F)
8. 200FT detection range
9. HU-3 heating unit
10. Pole mounting hardware

B. Locate exact location and aiming per manufacturer recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wire sizes and types shall be per manufacturer’s recommendations.

B. Install system according to National Electrical Code standards.

C. Provide a dedicated 120 VAC power circuit with 20 Amp breaker for security system.
D. Wiring Installation

1. Wiring Within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Mark each terminal according to the wiring diagrams of the system. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

2. System Wiring: For the low-voltage portion of the security system, install NO. 18 AWG conductors and 75-deg C insulation in wet, damp, or dry locations. For line-voltage wiring, install No. 12 Awg size with insulation rated 75 deg C minimum.

3. Color Coding: Color-code security system conductors differently from the normal building power wiring. Use one color code for alarm loop wiring and a different color for keypads, sounders, and auxiliary circuits.

4. Wiring to Central Station Transmitter: 1-inch (Size 27) conduit between the Security Control Panel and the central station transmitter connection as indicated. Install number of conductors and electrical supervision for connecting wiring as required to suit central-station monitoring function.

E. Field Quality Control

1. Manufacturer's Field Services: Provide services of a factory-trained service representative to supervise the field assembly and connection of components and the pretesting, testing and adjustment of the systems.

2. Pretesting: Upon completing installation of the system, align and adjust the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.

3. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

4. Minimum System Test: Test the system according to the procedures outlined by the manufacturer. Minimum required tests are as follows:

   a. Verify the absence of unwanted voltages between circuit conductors and ground.
   b. Megger test all conductors other than those intentionally and permanently grounded with electric components disconnected. Test for resistance to ground. Report readings less than 1-megohm for evaluation.
   c. Test all conductors for short circuits utilizing an insulation-testing device.
   d. Verify the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
   e. Test each initiating and sounding device for alarm operation and proper response at the control unit.
   f. Test the system for all specified functions according to the manufacturer's operating and maintenance manual. Systematically initiate specified functional performance items at each location including making all possible alarm and monitoring initiations and using all communication options. For each item, observe related performance items at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
5. **Retesting:** Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

**F. Cleaning and Adjusting**

1. **Cleaning:** Remove paint splatters and other spots, dirt and debris. Touch up scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by the manufacturer.

2. **Occupancy Adjustments:** When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3. **SMS contractor shall be responsible for all PIR sensor adjustment and required beam alignments to provide full coverage of designated area.**

**G. Demonstration**

1. **Provide the services of a factory-trained service representative to demonstrate the system and train Owner's maintenance personnel as specified below.**

   a. **Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining, of the system.** Provide a minimum of 4 hours' training.

   b. **Schedule training with the Owner at least seven days in advance.**

   c. **Provide the Owner with a professionally video taped operation and maintenance training seminar for the specific system installed under this Contract.** Video training tape shall include all operation, programming, functions and all aspects of the provided system.

**H. Warranty**

1. **The contractor shall warrant the completed security system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test.**

2. **The equipment supplier shall make available to the owner a contract proposal to provide ongoing maintenance of the system.**

END OF SECTION 28 1600
SECTION 28 2300 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The Security Management System (SMS) workstations, software, and security devices specified are designed around the Schneider Electric Andover Continuum Integrated Security system. The Schneider Electric Andover Continuum Security operating software resides on the school districts two servers located at the Quaker Valley Middle School. Through District’s Host Operators Workstation or from any PC in the district or Web Enabled PC, authorized users control and monitor all of the HVAC and Security functions of the Edgeworth Elementary School, Osborne Elementary School, Quaker Valley High School, and the Sewickley Valley Public Library. It is the school districts intent to keep the existing security system intact and for all new security systems to be seamlessly integrated into the existing security system operating software and SMS database residing on the two district servers. Additional software or third party operating software is not acceptable. No Exception.

C. The new CCTV security system shall utilize the existing security management data base to provide one unified security system of control and monitoring. The existing security management data base seamlessly manages all of the school districts critical systems from a single source. Those district wide systems consist of:

1. HVAC
2. CCTV
3. Access Control
4. Access Initiated Control
5. Vehicle Access Control
6. Time and Attendance
7. Lighting
8. Fire Alarm Monitoring
9. Intrusion Detection and Monitoring
10. Elevator Access and Control
11. Photo ID Badging
12. Remote HVAC/Security Alarm Notification
13. Occupied/Unoccupied Time Schedules
14. Web Accessible Systems
15. Building Lock Down
16. Integrated System Graphic Pages

D. Division 28 1600 Intrusion Control, Division 28 1300 Access Control apply to this section.

E. Requirements of this section include raceways, electrical boxes and fittings, wiring/cabling, and control/signal amplification and transmission media, as specified in applicable Division 28
Common Work Results for Electronic Safety and Security sections, which are used in conjunction with installation of this system.

F. Electrical contractor shall provide for all 110V power required for security devices.

1.2 SUMMARY

A. Furnish and install independent Closed Circuit Television Systems for the Pine-Richland High School. Provide all conduit, wire, outlets and equipment as indicated on the contract drawings and specified here-in.

B. It is the intent of this specification to outline the requirements for a complete and satisfactory operating CCTV surveillance system to be furnished and installed in the building areas. The system shall be wired, connected, adjusted and left in first class operating condition.

1.3 SYSTEM DESCRIPTION

A. Furnish and install an IP based CCTV System as indicated on the drawings and herein specified. This system shall include conduit, wiring, cameras, Network digital recorders, active receiver distribution amplifier hub, and all equipment required to make a complete and operating system.

B. All CCTV Systems specified in this specification shall be monitored and controlled over the school districts IP network utilizing the existing Schneider Electric Andover Continuum Integrated Security system software and its security management data base residing on the two districts SQL-Server. All CCTV system shall be seamlessly integrated with the existing district wide security system and operators workstation to provide one unified security system of control and monitoring. The districts SMS system provides control, monitoring, and triggers specific HVAC sequences along with CCTV and access control sequences and provides a graphical display on the operator’s integrated workstation of the CCTV system and related events. The SMS contractor shall coordinate equipment compatibility with the existing Andover SMS contractor before ordering and installing the CCTV systems specified. The SMS contractor shall make all final connections to the equipment under their scope of work. The SMS contractor shall be responsible to provide all labor, cost, and documentation to assist the existing SMS Andover contractor with the integration requirements of the installed SMS systems. The requirements of division 27, 28 and 26 apply to this section and the SMS contractor shall coordinate their work as it applies to those divisions.

C. The school district shall be responsible for furnishing the required IP drops and IP addresses and the SMS contractor shall be responsible for their respective system IP termination and system set up and operational check out.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Installer Certificates: Signed by Pelco Endura™ certifying that installers comply with manufacturers requirements for Installation.
C. Product Certificates: Signed by Pelco Endura™ as Certified for installation of equipment and components certifying that products furnished to the Contractor comply with requirements.

D. Product data for each type of product specified, including electrical characteristics and connection requirements. This product data shall include a complete listing of wire being proposed for the installation with all the corresponding specification sheets.

E. Provide a complete wiring diagram of the system including all equipment and wiring. The Contractor shall provide with the shop drawings a factory engineered system design detailing the system components along with a building floor plan indicating all field devices and the required wiring to the field devices.

F. Manufacturer's Installation and Operating Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

G. Maintenance Data: Maintenance Data for Distributed Network Video Surveillance System equipment and components shall be a part of the maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section “Contract Closeout,” include the following:

   1. Detailed operating instructions covering operation under both normal and abnormal conditions.
   2. Routine maintenance requirements for system components.
   3. Lists of spare parts and replacement components recommended are to be stored at the site for ready access.

1.5 RECORD DOCUMENTS

A. Provide maintenance data for materials and products, for inclusion in Operating and Maintenance Manual specified in Division 01 and Division 28 Section Common Work Results for Electronic Safety and Security. Provide complete manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover.

B. Provide complete test reports, which indicate satisfactory completion of required tests and inspections.

C. As-built drawings – These drawings shall include manufacturers’ specification sheets, including all the component parts. They should include up-to-date drawings that include any changes made to the system during installation. Circuit diagrams and other information necessary for the proper operation and maintenance of the system shall be included. Operating Instructions: These instructions shall be bound in a 3 ring binder.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: The technical representative shall furnish installation drawings and technical assistance to the Installing Contractor. At the completion of the installation, the
Technical Representative shall completely test the system. Documentation shall be provided to the Owner.

B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."

C. UL Compliance: Comply with requirements of UL.

1.7 MAINTENANCE SERVICE

A. The distributor shall provide a service and maintenance of the CCTV system for one year from the date of final acceptance, as part of this contract.

B. When requested by the Owner within one year of date of Substantial Completion, provide remote WEB assistance in adjusting viewing fields and adjusting controls to suit actual occupied conditions.

C. Occupancy Adjustments: When requested by the Owner within one year of date of Substantial Completion, provide on-site assistance in adjusting viewing fields and adjusting controls to suit actual occupied conditions. Provide site visits as required by the owner for this purpose.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Equipment in this Specification is based on products manufactured by Pelco and controlled through the existing Andover SMS server and related software and other specific manufacturers, and is intended as the standard equipment to be furnished which shall be consistent and compatible with the districts existing security system and its related server software. All manufacturers’ published specifications pertaining to this specialization shall have the same force and effect as if shown here in full.

B. Bases of Design; Schneider Electric Pelco Endura™ CCTV System of control and monitoring, no exception furnished by;

1. CS&E, Mike Brusco, 412-821-8900
2. Roth Brothers, Kevin Callahan, 330-270-2543
3. FIT, 412-367-6060

2.2 SYSTEM REQUIREMENTS

A. The IP CCTV system shall be provided exactly as specified below and as shown on the plans.
B. Digital Video Management Recording Units, (PELCO ENDURA®)

1. The Endura™ system shall be installed and programmed by a certified Endura™ dealer/integrator. The SMS contractor shall have successfully completed a factory certification course consisting of the Certified System designer (PCSD) and the Certified System Tech (PCST). Certification for installation shall be conducted by the manufacturer and shall provide all necessary knowledge to fulfill the systemization and deployment across diverse networks and infrastructures, as well as provide commissioning abilities at the integrator level.

2. The network video recorder shall operate from the existing Andover Continuum software and existing SMS workstations to provide a high-quality recorder capable of recording video and audio data streams over TCP/IP networks utilizing an Ethernet interface.

3. The security video system shall provide full video control with additional full selection capability at any point within the network from a workstation or a video console display. The security video system shall provide unlimited expansion capability for the addition or modification of video inputs.

4. The contractor shall furnish and install all security video cameras, mounts, housings, power supply systems, coaxial cable, network cables, connectors, equipment racks, monitors and consoles, computer controlled network switchers, work stations, network storage managers, video encoders, video decoders, video console displays and keyboards, and all other hardware and software to provide a fully operational system.

5. The IP video management system shall permit normal and event monitoring of all secured areas on digital monitors as required or shown in the specifications and drawings. In all cases, the equipment shall be state of the art, standardized commercial off-the-shelf, and modular. In all cases, the method of communication from remote locations within the network to the central components shall be transparent to the user. Equipment shall be selected and installed so repairs may be accomplished on site by module replacement, utilizing spare components whenever possible.

6. The IP video management system shall permit the normal and event monitoring of all secured areas on the IBAS workstations as required or shown in the specifications and drawings.

7. The IP video management system based digital recording and monitoring system shall incorporate a fault tolerant architecture and shall include redundancy in critical areas of concern. Power supplies for the encoder and Network Storage Managers shall be capable of redundancy. In addition, all Network Storage Managers shall provide RAID 6 redundancy for the storage drives.

8. The IP video management system shall provide multi-level diagnostics of each component in all critical areas. These diagnostics shall be reported to a diagnostic console for processing. In addition, the diagnostic data shall be capable of being scripted into actionable events within the system.

9. The digital video recording units (DVMSs) shall be seamlessly integrated into the IBAS Host system and shall operate through its HVAC/Security software. The DVMS’s shall function as a standalone system should the IBAS system fail to operate for any reason.

C. Video Management System Capabilities

1. The following describes the general architecture and basic functionality deemed essential for the IP video management system described in this specification.

2. The IP video management system shall be built upon open, industry standards and facilitate integration with IT infrastructures and other digital and analog systems.
3. The IP video management system shall provide an API/SDK that is capable of being used at a level consistent with a full-featured gateway. The gateway shall provide an RS232 ASCII interface, Ethernet interface, and the ability to create custom plug-ins to the system user interface.

4. The IP video management system shall support cameras that generate a standard NTSC/PAL composite video signal.

5. The IP video management system shall provide support for IP cameras from multiple manufacturers.

6. IP video management system shall support standard resolution and megapixel IP cameras.

7. The IP video management system shall have no restriction as to the resolution, frame rate, or number of standard resolution or mega pixel cameras that can be recorded, viewed, and managed on the system.

8. All displays shall retain the camera’s aspect ratio and accommodate 4:3, 16:9, or 16:10 monitor displays.

9. All components of the IP video management system shall be built upon a reliable and robust Linux operating system except for the Windows® workstation.

10. The system shall be fully distributed in nature so that each system device can remain operational in a majority of modes without dependence on other devices.

11. Multiple users shall be able to simultaneously view the same camera view or sequence. The system shall utilize multicast streaming video to allow multiple users to view the same video stream, though not necessarily synchronized with each other, without affecting the bandwidth of the network.

12. Video titling shall provide for a 100-character camera site description (on/off), display time/date (on/off), set the display color (black-white), display a site message (on/off), and define the screen block position for the title.

13. The IP video management system shall have the capability to create and execute a system script used to control and automate any system function. Scripts can be nested such that multiple actions can be taken off the same trigger. The configuration of such scripts shall be easy to use and follow the rules of drag and drop configuration. The IP video management system shall be capable of the following actions (minimal requirements):

   a. Display video from any camera to a specific monitor or screen division, including changing screen division views
   b. Reset any monitor to its original screen division and image
   c. Move system PTZ cameras to a specified preset location
   d. Activate predefined patterns on system PTZ cameras
   e. Start/stop recording an event from any indicated video source
   f. Utilize script nesting, a means of running another script within a script
   g. Activate system relays and send e-mail notification through POP3
   h. Add wait times to any script command.

13. The scripting language shall utilize a system function upload and will modify or send out a global command to all components in the system.

14. The IP video management system shall support sequences running on any network monitor. Alarms or user intervention shall be capable of interrupting a running sequence.

15. Operator control of a camera or selection of monitors shall override the sequence control of camera or monitor; sequence control of cameras or selection of monitors shall not override operator control of camera of selection of monitors.

16. The IP video management system shall allow for programming of alarms and associated incoming alarms with related parts of the system. Alarms and other triggers can be
grouped into system events. System events can be configured using Boolean logic that requires multiple entities to be true before a system event is triggered.

17. Individual, group, or all alarms shall be disabled by special sequences, which can be initiated by the operator or automatically by time/day/date.

18. The IP video management system shall log all alarms and events in the system manager database.

19. The IP video management system shall provide for virtual matrix functionality, leveraging the IP network to switch any camera to any monitor either through a PC Keyboard/Mouse or a joystick controller as well as transmit alarms and other system messages to any console on the network.

20. The IP video management system shall utilize a system manager to provide user and database management.

21. The system manager software shall support database failover when utilizing two servers by maintaining a continuously synchronized duplicate of the main database at all times.

22. To ensure system security and integrity, the IP video management system shall incorporate a methodology for validating the authenticity of the source of any video or communication message before recording, displaying, or acting on that message. One example of such a methodology is the use of the RSA 256-bit public/private key authentication scheme. All video generated by IP cameras or video encoders shall be digitally signed using the device’s public key prior to the content being recorded or displayed by a receiving device.

23. The system manager shall retain all private keys and messages shall be authenticated with the system manager prior to an action being carried out. In addition, this scheme shall allow for authenticating the validity and integrity of any exported video from the system as all video will be digitally signed as it is being generated by the IP camera or video encoder and prior to it being recorded to a disk drive.

24. The IP video management system’s digital recording sub-system shall incorporate a distributed, load balancing architecture and provide fault tolerance and redundancy in critical areas of concern. The hardware shall be designed such that all serviceable components can easily be replaced or maintained without the need to take the storage system off-line. As a standard, all network storage devices shall provide RAID 6 redundancy to safeguard the data in the event of any hard disk drive failure.

25. The IP video management system shall provide multilevel diagnostics of each component in all critical areas. These diagnostics shall be reported to a diagnostic console for processing. The diagnostic data shall be capable of being scripted into actionable events within the system. In addition, standard SNMP messages shall be capable of being mined by network diagnostic systems such as OpenView, Tivoli, and others for diagnostic traps and operational data.

26. The IP video management system shall support intelligent edge devices for video motion detection and analytics analysis. Motion detection shall allow for the configuration of:

   a. Three independently configured groups of activity detection zones to be utilized.
   b. Each zone can be programmed with its own specific sensitivity level and configured for a specified threshold
   c. Video motion shall be capable of enabling motion-based search routines, triggering relays, or executing scripted responses.

27. Video analytics shall utilize the processing power of the video encoder or IP camera to analyze live video on a continuous or scheduled basis. If programmed for scheduled operation, different analytic behaviors shall be capable of being loaded at different schedules or upon user command. Analytic analysis shall be capable of being done
entirely within the edge device or IP camera and without requiring an analytics server for processing. Analytics behaviors shall, at a minimum include the following:

a. Directional motion, which shall be capable of triggering an alarm only if an object moves in a certain direction.
b. Adaptive motion, which shall be capable of monitoring a moving object and only trigger an alarm if the object enters a designated area.
c. Video vibration removal, which shall be capable of removing vibration from unstable mounting of the camera.
d. Object removed, which shall trigger an alarm should a designated object be removed from the scene.
e. Object left behind, which shall trigger an alarm should a foreign object be deposited in the scene.
f. Object counting, which shall maintain an accurate count of all objects entering a defined zone or moving in a given direction past a designated spot.
g. Camera sabotage, which shall trigger an alarm should it detect attempted sabotage such as obstructing the lens or moving the camera without authorization.

D. System Manager

1. The system manager shall support database redundancy by utilizing two servers and maintaining constant synchronization between the two servers. In the event of a system manager failure, the hot standby shall assume management responsibilities until the failed unit is restored. No loss of functionality, recording, or monitoring capability shall occur during the failover process.

2. The system manager shall serve as the security key server for the entire system and manage device registration and message authentication using the RSA 256-bit public/private key system.

3. The system manager shall be capable of serving as an NTP Server for the entire system. The IP video security system shall be synchronized to an NTP server so that all system components function on the same time basis. The NTP server shall reside within the system, and it shall be capable of being driven by external time sources if needed. All time-zone corrections shall automatically be provided in the system.

4. The system manager shall be capable of performing as a DHCP and UPnP server for the entire system and components. The system manager shall provide all connection and management communications between system devices.

5. The system manager shall be capable of authenticating any video produced by an encoder or camera that originally produced the stream, NSM recording the stream, operator who exported the stream, all with time/date stamped video.

6. The system manager shall manage rights and permissions for all devices, persons, and any system video or other data.

7. Hardware and software platform that serves as the system management component. It shall provide distributed administration of multiple devices and administer rights and privileges for all attached devices.

8. The system manager shall manage system security, functioning as a key server for user and device authentication, and it shall route communication between all devices on large, subnetted security networks. The system manager shall store and administer secure keys and shall have multi-level and user permission management.

9. The system manager shall function as the default system time server, using the industry standard NTP protocol, to ensure integrated devices are synchronized. The system
The system manager shall store the database of device errors, alarms, and other system events, and the comprehensive database shall be accessed and searched through the system log window in an interface.

E. Video Storage

1. The network storage manager shall record video and audio streams from IP cameras and video encoders on the network.
2. The network storage manager shall incorporate the server functions and storage elements into a purpose-built chassis.
3. The network storage manager shall use RAID 6 parity across the storage drives to protect recorded data against a hard disk drive failure.
4. The network storage manager shall only use enterprise-level hard disk drives specifically rated for operation in RAID systems.
5. The network storage manager shall support the recording of MPEG-4 and H.264 baseline, and high profile streams from standard resolution and megapixel cameras.
6. The network storage manager shall support continuous, scheduled, alarm/event (including analytics alarms), motion, and manual recording. Pre- and post-alarm periods shall be configurable up to the total capacity of the system.
7. The network storage manager shall support a guaranteed recording throughput of 250 Mbps per storage device with a minimum of 64 Mbps of read throughput. This throughput shall be guaranteed under normal and error (RAID rebuild) conditions.
8. The network storage manager shall support any number of cameras so long as the maximum throughput required is less than 250 Mbps.
9. The network storage manager shall support the recording of MPEG-4 and H.264 baseline, and high profile streams from standard resolution and megapixel cameras.
10. The network storage manager shall support a guaranteed recording throughput of 250 Mbps per storage device with a minimum of 64 Mbps of read throughput. This throughput shall be guaranteed under normal and error (RAID rebuild) conditions.
11. The network storage manager shall support any number of cameras so long as the maximum throughput required is less than 250 Mbps.
12. The network storage manager shall support privacy tools that allow administrators to establish maximum retention times for normal, alarm, and locked video.
13. The network storage manager shall support an intelligent video grooming protocol that can reduce the frame rate of recorded video as the video ages. Administrators shall have the flexibility to determine whether to groom alarm video or leave it at its real-time level.
14. The network storage manager shall have the ability to report all diagnostic events, including software status diagnostics to a centralized user interface. In addition, Simple Network Management Protocol (SNMP) traps shall be available for monitoring through a third-party SNMP management console.
15. The network storage manager shall be fully managed from a remote workstation, including the ability to configure settings and update firmware and software.
16. The network storage manager shall be capable of interfacing with the APC® Smart-UPS® using a USB connector. The network video recorder shall receive status and control signals from the uninterruptible power supply (UPS) when it is in backup mode. This function shall inform the operator about the amount of charge remaining and trigger a controlled shutdown when the charge becomes zero.
F. Workstation

1. The PC workstation shall be a server-class personal computer with two dual-link DVI-I monitor outputs, USB keyboard, and mouse.
2. The PC workstation shall use a graphical user interface and keyboard/mouse that runs on 32-bit Microsoft® Windows Vista® Business for monitoring live and recorded video, and virtual matrix functionality that shall allow operators to see and respond to any alarm from any device on the network as well as direct any camera to any monitor on the network.
3. The PC workstation shall allow administrators to configure devices, set up users, adjust network settings, and create recording schedules. Permission to access these functions and all other system services shall be configured to a fine level of detail including the ability to restrict cameras from viewers, restrict PTZ operation, allow or restrict digital zoom, Zone of Interest™ operations, or the ability to configure maps. In addition, user permissions shall allow for designated users to receive and respond to alarm and system diagnostic messages.
4. The PC workstation shall have advanced search capabilities, event logging, and alarm interface displays. The PC workstation shall export video and still images in multiple formats, including Pelco Native, QuickTime® MPEG-4, H.264, AVI, BMP, and JPG. The unit shall provide a front panel USB port and DVD/CD-RW drive to make it capable of exporting video clips and still images to external media. Authentication software shall be exported automatically for any Pelco Native exports.
5. The PC workstation shall allow users with authority to monitor content from standard resolution and megapixel resolution cameras and encoders throughout the network. The PC workstation shall display content encoded in MPEG-4 and H.264 baseline, main, and high profiles. The PC workstation shall support cameras from multiple manufacturers.
6. The PC workstation shall be capable of decoding up to 16 simultaneous 4CIF resolution, 30 images per second (ips) video streams encoded in MPEG-4; or 12 simultaneous 4CIF resolution, 30 ips video streams encoded in H.264 baseline profile; or 2 simultaneous 1080p video streams encoded in H.264 baseline profile.
7. The PC workstation shall be capable of minimizing the CPU processing load and network bandwidth required by EnduraView™, a scheme that shall automatically seek out and subscribe to a secondary stream from the cameras or encoders at a lower resolution when the display is changed to a multichannel display.
8. The PC workstation shall support CCTV-style (joystick) keyboard control of pan/tilt/zoom (PTZ) cameras and camera call-up.
9. The PC workstation shall detect the monitor’s native resolution; provide users with single, 2 x 2, 3 x 3, 4 x 4, 1 + 5, 1 + 12, 2 + 8 displays for 4:3 aspect ratio monitors, and provide 3 x 2 and 4 x 3 displays for 16:9 aspect ratio monitors.
10. The PC workstation shall retain the camera’s aspect ratio and allow mixing standard resolution and megapixel resolution cameras on the same display.
11. The PC workstation shall allow any combination of live or playback video on the same monitor at the same time. The workstation shall provide time-synchronized playback of up to 16 cameras simultaneously.
12. The PC workstation shall provide digital zoom capability for any camera in live or playback mode.
13. The PC workstation shall provide a Zone of Interest feature that can generate up to six independently controlled and zoomed images from a single image and allow operators to maintain a panoramic view of the scene while closely monitoring selected areas. This shall be accomplished without requiring additional network throughput.
14. The system shall be capable of customizing the display area to suit user preferences. All aspects of the graphical user interface shall be capable of being resized, torn-off and moved to other monitors, or simply hidden. The system shall allow up to 6 customizable workspaces to be created and loaded with camera groups to facilitate easy and efficient monitoring. The system shall allow for up to two detachable video display windows to accommodate up to a 32-camera display.

15. The PC workstation shall automatically load a user’s language preferences, camera groups, and screen configurations upon log on. The PC workstation shall also support languages that do not use the Latin alphabet such as Chinese, Korean, Turkish, and Arabic.

16. The PC workstation shall notify designated operators of all alarms on the system in an alarm tab. Video thumbnails shall be available for visual verification within the alarm monitoring workspace. The system shall allow alarms to be acknowledged or snoozed by the operator. The PC workstation application shall support the functionality to view procedures and instructions for given alarms triggered to appear during alarm events, while generating detailed written or verbal instructions to the operator as to the actions to be taken. An operator shall have the capability of entering his or her own feedback to the given alarm. All user alarms and user actions shall be kept in the system log for audit purposes.

17. The PC workstation application shall provide the ability to control and program any camera equipped with PTZ. The PC workstation shall be capable of the following operations:

   a. Manually control the PTZ
   b. Set the pan/tilt home positions for manual or alarm activation
   c. Automatically control the cameras through an alarm trigger
   d. Ability to set multiple preset positions
   e. Ability to set multiple tours
   f. Remotely set and clear the movement limits of the pan/tilt mechanism from the control room, through a telemetry unit at an outdoor camera site
   g. Adjust the zoom lens
   h. Ability to control the camera menu and set up the camera through the IP video security system

18. The workstation shall meet or exceed the following design and performance specifications:

   a. System Specifications:

      1) Processor Intel® Core™ 2 Quad
      2) Internal Memory 4 GB RAM
      3) Operating System Windows Vista Business SP1, 32-bit version
      4) User Interface Graphical User Interface, WS5200 version 2.x, advanced system management software
      5) Video System Graphics card with 512 MB video RAM (nonshared memory), 2560 x 1600 display resolution, and DirectX® 9 API; true color (32-bit), 2 dual-link DVI outputs

   b. Video Specifications
1) Video Output: 2 DVI or VGA outputs (2 DVI-to-VGA supplied)

2) Video Decoding: MPEG-4, H.264 baseline, main, and high profile

3) Video Decoding Performance:

<table>
<thead>
<tr>
<th></th>
<th>MPEG-4 Encoded</th>
<th>H.264 Encoded</th>
</tr>
</thead>
<tbody>
<tr>
<td>4CIF</td>
<td>16 streams at 30 ips</td>
<td>12 streams at 30 ips</td>
</tr>
<tr>
<td>2CIF</td>
<td>16 streams at 30 ips</td>
<td>12 streams at 30 ips</td>
</tr>
<tr>
<td>CIF</td>
<td>16 streams at 30 ips</td>
<td>12 streams at 30 ips</td>
</tr>
<tr>
<td>Megapixel</td>
<td>N/A</td>
<td>2 1080 streams at 30ips</td>
</tr>
</tbody>
</table>

4) Video Display Modes: Single image, 2 x 2, 3 x 3, 4 x 4, 1 + 5, 1 + 12, 2 + 8 and 3 x 2 and 4 x 3 for 16:9 aspect ratio monitors

5) Audio

1) Audio Decoding: G.711 speech codec

2) Audio Bit Rate: 64 kbps

3) Audio Levels

4) Input: Electret microphone

5) Output: Up to 3 Vp-p, adjustable, minimum load of 8 ohms

6) Audio Inputs: 2, 3.5 mm stereo jacks

7) Audio Outputs: 1, 3.5 mm stereo jack

6) PTZ Control Specifications

1) PTZ Interface: On-screen

7) Network Specifications

1) Interface: Gigabit Ethernet RJ-45 port, (1000 Base-T)

2) Security: 2 modes: secure mode (device authentication) and unsecured mode

8) Front Panel Specifications

1) DVD/CD-RW Drive

   a) CD read/write speed: 24X
   b) CD rewrite speed: 24X
   c) DVD read/write speed: 8X
   d) DVD rewrite speed: 6X6/4X (dual layer)

2) Buttons: Power, configuration/reset

9) Indicators

1) Power: Blue if power

2) Network Activity: Flashing Green, amber, red

3) Unit Status: Green, amber, red

10) Power Specifications
1) Power Input 100 to 240 VAC, 50/60 Hz, autoranging
2) Power Supply Internal
3) Power Consumption Operating Maximum
   a) 100 VAC 129 W, 440 BTU/H
   b) 115 VAC 128 W, 437 BTU/H
   c) 220 VAC 127 W, 433 BTU/H

19. Power Cord
   a. USA standard (117 VAC, 3 prongs, molded connector, 6 ft or 1.8 m); or
      European standard (220 VAC, 3 prongs, molded connector, 6 ft or 1.8 m); or
      UK standard (250 VAC, 3 prongs, molded connector, 6 ft or 1.8 m); or
      Argentina standard (250 VAC, 3 prongs, molded connector, 8 ft or 2.4 m); or
      Australia standard (250 VAC, 3 prongs, molded connector, 6 ft or 1.8 m)
   b. Environmental Specifications
      1) Operating Temperature 50°C to 95°F (10°C to 35°C)
      2) Operating Humidity 20% to 80%, noncondensing
      3) Maximum Humidity 10% per hour
      4) Operating Altitude -50 to 10,000 ft (-16 to 3,048 m)
      5) Operating Vibration 0.25 G at 3 to 200 Hz at a sweep rate of 0.5 octave/minute
   c. Physical Specifications
20. Construction Steel cabinet
21. Finish
   a. Front panel Gray metallic with black end caps
   b. Chassis Black matte finish
   c. Dimension 17.0” D x 17.1” W x 3.5” H (43.2x43.4x8.9 cm)
22. Mounting Desktop (feet) or rack (2 RU per unit)
23. Unit Weight 28.8 lb (13.06 kg)
   a. Auxiliary Interfaces
      1) USB 2.0 7, USB 2.0 ports (1 front, 6 rear)
   b. Certifications
   c. CE, Class B; meets EN50130-4 standard requirements
   d. FCC, Class B
   e. UL Listed/cUL Listed
   f. C-tick
   g. Warranty
      1) 36 months, parts and labor
   h. Supplied Accessories
1) 1 power cord (standard cord per country designation; Chinese model does not include a power cord)
2) 1 keyboard
3) 1 mouse
4) 1 rack-mounting kit (for mounting in 2 RU rack)
5) 1 resource disc

i. Pelco Model Number

1) WS5070 Endura Workstation console with standard keyboard and mouse; includes a single license of advanced system management software (WS5200-1), and a regional power cord.

G. Virtual Console Display

1. The video console display shall decode and display IP streams from cameras and encoders across the network.
2. The video console display shall drive two HD (maximum of SVGA resolution, 2560 x 1600) monitors through DVI connections.
3. The video console display shall decode video streams encoded in MPEG-4 simple profile and H.264 baseline, main, or high profiles.
4. The video console display shall decode two 1080p H.264 baseline streams, four 720p H.264 baseline streams, twelve 4CIF H.264 baseline streams, or sixteen 4CIF MPEG-4 streams in real time. Up to a maximum of 32 cameras can be displayed across both monitors.
5. The video console display shall use EnduraView™ technology to automatically subscribe to a lower resolution, lower bit-rate secondary stream from the camera to reduce network bandwidth and CPU processing requirements as screen configurations dictate.
6. The video console display shall allow for simultaneous live and playback viewing of the same camera on the same monitor.
7. The video console display shall utilize a heads-up, icon-based menu structure coordinated with a CCTV-style keyboard, which shall allow operators to navigate through functionality without losing view of the scene.
8. The video console display shall support searching for video content through camera, time, date, or event.
9. The video console display shall support jog-shuttle-based rewind, fast-forward including frame by frame advance and 120X fast forward.
10. The video console display shall support locking and unlocking archived video as well as exporting evidence-worthy clips and snapshots to a USB solid state device or CD/DVD ROM.
11. The video console display shall be built upon the Linux® operating system.
12. The video console display shall support systemized diagnostics with a management server or user interface as well as transmit Simple Network Management Protocol (SNMP) messages and traps to a network monitoring system. SNMP shall be compatible with SNMP versions 1 and 2.
13. The video console display shall meet or exceed the following design and performance specifications.

a. Power Specifications

1) Power Input 100 to 240 VAC, 50/60 Hz, autoranging
2) Power Supply Internal
3) Cable Type 1 USA standard (117 VAC);
   1 European (220 VAC);
   1 United Kingdom (250 VAC);
   1 Argentinean (250 VAC); or
   1 Australian (250 VAC);
   All, 3 prongs, molded connector

b. Power Consumption

   1) 100 VAC 129 W, 440 BTU/H
   2) 115 VAC 128 W, 437 BTU/H
   3) 220 VAC 127 W, 433 BTU/H

14. Environmental Specifications

   a. Operating Temperature 50° to 95°F (10° to 35°C)
   b. Operating Humidity 20% to 80%, noncondensing
   c. Maximum Humidity 10% per hour
   d. Operating Altitude –50 to 10,000 ft (–15 to 3,048 m)
   e. Operating Vibration 0.25 G at 3 to 200 Hz at a sweep rate of
      0.5 octave/minute

15. Physical Specifications

   a. Construction Steel cabinet
   b. Finish

      1) Front Panel Gray metallic with black end caps
      2) Chassis Black matte finish

   c. Dimensions 17.0” D x 17.1” W x 3.5” H (43.2x43.4x8.9 cm)
   d. Unit Weight 28.8 lb (13.06 kg)
   e. Mounting Desktop (feet) Rack, 2 RU per unit (rack rails
      and hardware are supplied)

16. System Specifications

   a. Video

      1) Video Output XVGA (2560 x 1600); 60 Hz capability for NTSC; 75z
         capability for PAL
      2) Video Decoding 2 H.264 baseline 1080p; 4 H.264 baseline 720p; 12
         H.264 baseline 4CIF; or 16 MPEG-4 4CIF resolution streams in real time
      3) Video Codec MPEG-4 simple profileH.264 baseline, main, or high profiles
      4) Video Outputs 2 DVI or VGA outputs (2 DVI-to-VGA adapters Max
         Decoded Streams 32

   b. Audio

      1) Audio Decoding G.711 speech codec
2) Audio Bit Rate 64 kbps
3) Audio Inputs Microphone and line in through KBD300
4) Audio Outputs Speaker or line out through KBD5000

c. PTZ Control
1) PTZ Interface Through KBD5000

d. Network
1) Interface Gigabit Ethernet RJ-45 port (1000Base-T)
2) Auxiliary Interfaces
3) USB 2.0 Ports 6 on rear panel; 1 on front panel

e. Front Panel Indicators/Functions
1) DVD+/RW/CD-RW Drive
2) CD Read/Write Speed 24X
3) CD Rewrite Speed 24X
4) DVD Read/Write Speed 8X
5) DVD Dual Layer
6) Read/Write Speed 8X/6X
7) Power Blue for power
8) Network Activity Green or red for activity
9) Unit Status Green, amber, red

f. Certifications
1) CE, Class A, meets EN50130-4 standard requirements
2) FCC, Class A
3) UL/cUL Listed
4) C-Tick
5) S Mark for Argentina
6) CCC

g. Supplied Accessories
1) Power Cords 1 (based on country designation)
2) Rack Mount Kit Brackets, rails, and hardware
3) Bezel Key 2 bezel keys
4) Converters 2 DVI-to-VGA converters

h. Warranty
1) 12 Months, parts and labor

i. Pelco Model Numbers VCD5202 Endura video console display with regional power cord.
H. NETWORK STORAGE MANAGER

1. The network storage manager shall record video and audio streams from IP cameras and video encoders on the network.
2. The network storage manager shall incorporate the server functions and storage elements into a purpose-built chassis.
3. The network storage manager shall use RAID 6 parity across the storage drives to protect recorded data against a hard disk drive failure.
4. The network storage manager shall only use enterprise-level hard disk drives specifically rated for operation in RAID systems.
5. The network storage manager chassis shall be designed for video surveillance recording applications and encompass redundancy at all vital points:
   a. Redundant, hot swappable power supply modules
   b. Hot swappable O/S drive
   c. Hot swappable CPU fans
7. The network storage manager chassis shall be designed for online service and maintenance and cannot be removed from the rack when hard disk drives, fans, power supplies, or operating system drives must be replaced.
8. The network storage manager shall be built upon a reliable and robust Linux® operating system.
9. The network storage manager shall support a guaranteed recording throughput of 250 Mbps per storage device with a minimum of 64 Mbps of read throughput. This throughput shall be guaranteed under normal and error (RAID rebuild) conditions.
10. The network storage manager shall support any number of cameras so long as the maximum throughput required is less than 250 Mbps.
11. The network storage manager shall support the recording of MPEG-4 and H.264 baseline, and high profile streams from standard resolution and megapixel cameras.
12. The network storage manager shall support continuous, scheduled, alarm/event (including analytics alarms), motion, and manual recording. Pre- and post-alarm periods shall be configurable up to the total capacity of the system.
13. The network storage manager shall support bookmarking and locking/unlocking of video content on the drives.
14. The network storage manager shall support privacy tools that allow administrators to establish maximum retention times for normal, alarm, and locked video.
15. The network storage manager shall support an intelligent video grooming protocol that can reduce the frame rate of recorded video as the video ages. Administrators shall have the flexibility to determine whether to groom alarm video or leave it at its real-time level.
16. The network storage manager shall have the ability to report all diagnostic events, including software status diagnostics to a centralized user interface. In addition, Simple Network Management Protocol (SNMP) traps shall be available for monitoring through a third-party SNMP management console.
17. The network storage manager shall be fully managed from a remote workstation, including the ability to configure settings and update firmware and software.
18. The network storage manager shall be capable of interfacing with the APC® Smart-UPS® using a USB connector. The network video recorder shall receive status and control signals from the uninterruptible power supply (UPS) when it is in backup mode. This function shall inform the operator about the amount of charge remaining and trigger a controlled shutdown when the charge becomes zero.
19. The network storage manager shall meet or exceed the following design and performance specifications.

a. Power Specifications

1) Power Input 100 to 240 VAC, 50/60 Hz, autoranging
2) Power Supply Internal, dual-redundant, hot-swappable
3) Cable Type 2 USA (117 VAC); or 2 European (220 VAC); or UK (250 VAC); or 2 Argentinean (250 VAC); or 2 Australian (250 VAC); All, 3 prongs, molded connector

b. Power Consumption

1) 100 VAC 262 W, 2.65 A, 895 BTU/H
2) 115 VAC 263 W, 2.31 A, 895 BTU/H
3) 220 VAC 254 W, 1.25 A, 868 BTU/H
4) UPS Compatible with APC Smart-UPS, managed through the Endura® product architecture

20. Environmental Specifications

a. Operating Temperature 50°F to 95°F (10°C to 35°C) at unit intake
b. Operating Humidity 20% to 80%, noncondensing
c. Maximum Humidity 10% per hour
d. Operating Altitude –50 to 10,000 ft (–16 to 3,048 m)
e. Operating Vibration 0.25 G at 3 to 200 Hz at a sweep rate of 0.5 octave/minute

21. Physical Specifications

a. Construction Steel cabinet
b. Finish
1) Front Panel Gray metallic with black end caps
2) Chassis Black matte finish
3) Dimensions
   a) Without Rails 24.3" D x 17.0" W x 5.2" H
      (61.8 x 43.2 x 13.2 cm)
   b) With Rails 24.7" D x 19.0" W x 5.2" H
      (62.7 x 48.26 x 13.2 cm)
c. Unit Weight
   1) Empty 46 lb (21 kg)
   2) Fully Equipped 67 lb (30 kg)
d. Mounting Desktop (feet); Rack, 3 RU per unit (Rack rails and hardware provided)

22. System Specifications
a. System Drive       Linux CompactFlash system drive
b. RAID Level         RAID 6 for storage drives
c. Effective Capacity  Up to 9.082 TB
d. Drive Interface    SATA/SATA II
e. Network
   1) Interface       2, 1 Gigabit Ethernet RJ-45 ports (1000Base-T)
      a) Security      2 modes: secure mode (device authentication) and unsecured mode
   2) Auxiliary Interfaces
      a) USB 2.0       2 USB 2.0 Ports on rear panel
      b) 1 USB 2.0 port on front panels
f. Front Panel Indicators/Functions
   1) Power           Blue Pelco badge
   2) Software Status  Green, Amber Red (based on diagnostics)
   3) Network Port 1 Speed  Green, Amber, Red
   4) Network Port 2 Speed  Green, Amber, Red
   5) Hardware Status  Green, amber, red
   6) Hard Drive Status  Green, red
   7) Power Button    On, off (soft), off (hard)

23. Certifications
   a. CE, Class A
   b. FCC, Class A
   c. UL/cUL Listed
   d. C-Tick
   e. S Mark for Argentina
   f. CCC/CQC

24. Warranty
   a. 36 Months, parts and labor

25. Pelco Model Numbers
   a. NSM5200-03       Network storage manager, 3 TB storage
   b. NSM5200-06       Network storage manager, 6 TB storage
   c. NSM5200-09       Network storage manager, 9 TB storage
   d. NSM5200-12       Network storage manager, 12 TB storage
   e. NSM5200-24       Network storage manager, 24 TB storage
   f. NSM5200F-03      Network storage manager, 3 TB storage with optional Fibre-channel Expander
g. NSM5200F-06      Network storage manager, 6 TB storage with optional Fibre-channel Expander
   h. NSM5200F-09      Network storage manager, 9 TB storage
I. INDOOR IDE20DN81 SERIES SARIX™ ID INTEGRATED FIXED DOME

1. General
   a. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer’s system.
   b. All systems and components shall have been thoroughly tested and proven in actual use.
   c. All systems and components shall be provided with the availability of a toll-free (U.S.), 24-hour technical assistance program (TAP) from the manufacturer. The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.
   d. All systems and components shall be a product of one manufacture and supported by the IBAS system. All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and non warranty items.

2. Product Features
   a. The network camera shall offer auto back focus (ABF) functionality through a push button on the camera. ABF parameters shall also be configurable through a standard Web browser interface.
   b. The network camera shall offer dual video streams with up to 2.1 MPx resolution (1920 x 1080) in progressive scan format.
   c. The extended platform shall give real-time video (30 ips) with 1080p HD resolution using H.264 compression for optimized bandwidth and storage efficiency.
   d. Pelco Analytic Suites shall include Camera Sabotage, Abandoned Object, Adaptive Motion, Directional Motion, Loitering Detection, Object Counting, Object removal, and Stopped Vehicle.
   e. Vandal-resistant, Indoor/Outdoor Environmental
   f. Sarix outdoor fixed dome network camera EP with built-in Pelco Analytics, 2.1 MPx, day/night, 2.8~8mm varifocal megapixel lens, clear dome
   g. Color and day/night modes
   h. Sensitivity down to 0.03 lux
   i. Power over Ethernet (POE), IEEE 802.3af
   j. Up to two simultaneous video streams
   k. Web Viewing, up to 16 cameras simultaneously
   l. Open IP Standards
   m. The network camera shall have a window blanking feature to conceal user-defined privacy areas that cannot be viewed by an operator. The network camera shall support up to four blanked windows. A blanked area shall appear on the screen as a solid gray window.
   n. Wide Dynamic Range, 60db
J. OUTDOOR IEE20DN8-1 SERIES SARIXTM EP INTEGRATED RUGGED ENVIRONMENTAL FIXED DOME

1. General
   a. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer’s system.
   b. All systems and components shall have been thoroughly tested and proven in actual use.
   c. All systems and components shall be provided with the availability of a toll-free (U.S.), 24-hour technical assistance program (TAP) from the manufacturer. The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.
   d. All systems and components shall be a product of one manufacture and supported by the IBAS system. All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and non warranty items.

2. Product Features
   a. Up to 0.5 Megapixel resolution (800x600)
   b. Up to 30 images per second (ips) at All Resolutions
   c. Vandal-resistant, Indoor/Outdoor Environmental
   d. Autofocus Varifocal 2.8-10 mm lens
   e. Color and day/night modes
   f. Sensitivity down to 0.03 lux
   g. Power over Ethernet (POE), IEEE 802.3af
   h. Up to two simultaneous video streams
   i. Web Viewing, up to 16 cameras simultaneously
   j. Open IP Standards
   k. Built-in Analytics
   l. Window Blanking
   m. Wide Dynamic Range, 60db
   n. White Balance Rang 2,000° to 10,000°K
   o. Sensitivity, f/1.3, 2,850°K, SNR >24 db

K. OUTDOOR IMSODN10-1-E SERIES SARIX NETWORK ENVIRONMENTAL MINI FIXED DOM DIGITAL CAMERA

1. General
   a. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer’s system.
   b. All systems and components shall have been thoroughly tested and proven in actual use.
   c. All systems and components shall be provided with the availability of a toll-free (U.S.), 24-hour technical assistance program (TAP) from the manufacturer. The
TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.

d. All systems and components shall be a product of one manufacture and supported by the IBAS system. All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and non warranty items.

2. Product Features

a. Up to 0.5 Megapixel resolution (800x600)
b. Up to 30 images per second (ips) at All Resolutions
c. Rugged indoor vandal-resistant
d. Autofocus Varifocal 2.8-10 mm lens
e. Color and day/night modes
f. Sensitivity down to 0.03 lux
g. Power over Ethernet (POE), IEEE 802.3af
h. Up to two simultaneous video streams
i. Web Viewing, up to 16 cameras simultaneously
j. Open IP Standards
k. Built-in Analytics
l. Window Blanking
m. Wide Dynamic Range, 60db
n. White Balance Rang 2,000° to 10,000°K
o. Sensitivity, f/1.3, 2,850°K, SNR >24 db

L. INDOOR IMSODN10-1-V SERIES SARIX NETWORK VANDAL-RESISTANT MINI FIXED DOME DIGITAL CAMERA

1. General

a. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer’s system.
b. All systems and components shall have been thoroughly tested and proven in actual use.
c. All systems and components shall be provided with the availability of a toll-free (U.S.), 24-hour technical assistance program (TAP) from the manufacturer. The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.
d. All systems and components shall be a product of one manufacture and supported by the IBAS system. All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and non warranty items.

2. Product Features

a. Up to 0.5 Megapixel resolution (800x600)
b. Up to 30 images per second (ips) at All Resolutions
c. Rugged indoor vandal-resistant
d. Autofocus Varifocal 2.8-10 mm lens
e. Color and day/night modes
f. Sensitivity down to 0.03 lux
g. Power over Ethernet (POE), IEEE 802.3af
h. Up to two simultaneous video streams
i. Web Viewing, up to 16 cameras simultaneously
j. Open IP Standards
k. Built-in Analytics
l. Window Blanking
m. Wide Dynamic Range, 60db
n. White Balance Rang 2,000° to 10,000°K
o. Sensitivity, f/1.3, 2,850°K, SNR >24 db

M. DF8 SERIES FIXED MOUNT DOME HOUSING

1. General
   a. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer’s system.
   b. All systems and components shall have been thoroughly tested and proven in actual use.
   c. All systems and components shall be provided with the availability of a toll-free (U.S. and Canada), 24-hour technical assistance program (TAP) from the manufacturer.- The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.
   d. All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and nonwarranty items.

2. Fixed Mount Dome Product Features
   a. The fixed mount domes are 8 inches in diameter, shall allow for easy installation, and shall allow for indoor/outdoor applications. The versatile fixed camera mount shall allow for 360 degree horizontal positioning and shall accommodate a camera and lens up to 8.75 inches (22.23 cm) in length when tilted to 30 degrees. The lower dome, which is 8.3 inches (21.08 cm) in diameter, is easily removed for quick camera access.
   b. The fixed mount in-ceiling models shall allow for installation into hard ceilings or standard 2 feet x 2 feet (61 x 61 cm) suspended ceilings. This compact dome requires as little as 5.2 inches (13.2 cm) of overhead space above the ceiling for installation. The fixed mount pendant models shall mount directly to any recommended mount, flush to a ceiling, or to 1.5 NPT female pipe threads. The environmental domes shall include a sun shield and heater kit and are suitable for use in temperatures to -60°F (-51°C).
   c. The fixed mount dome shall meet or exceed the following design and performance specifications.

3. Electrical Specifications
   a. Input Voltage 14-30 VAC (outdoor models only)
   b. Input Power 58 VA at 24 VAC (for heater)
4. Environmental Specifications
   a. Environment: Indoor/outdoor
   b. Operating Temperature
      1) Indoor: 32°F to 120°F (0°C to 49°C)
      2) Outdoor*: 140°F (60°C) absolute maximum;
                     122°F (50°C) sustained maximum;
                     -60°F (-51°C) absolute minimum;
                     prevents icing at sustained minimum of -50°F (-45°C);
                     de-ices 0.1 inch (2.5 mm) within 3 hours
                     after power-up.
                     *Assumes no wind chill factor

N. EH3512/EH3515 SERIES OUTDOOR ENCLOSURE

1. General
   a. All equipment and materials used shall be standard components that are regularly
      manufactured and used in the manufacturer’s system.
   b. All systems and components shall have been thoroughly tested and proven in
      actual use.
   c. All systems and components shall be provided with the availability of a toll-free
      (U.S. and Canada), 24-hour technical assistance program (TAP) from the
      manufacturer. The TAP shall allow for immediate technical assistance for either
      the dealer/installer or the end user at no charge for as long as the product is
      installed.
   d. All systems and components shall be provided with a one-day turnaround repair
      express and 24-hour parts replacement. The repair and parts express shall be
      guaranteed by the manufacturer on warranty and non-warranty items.

2. Outdoor Enclosure
   a. The outdoor enclosure shall allow the use of cameras with fixed focal length lenses
      or motorized zoom lenses (with or without auto iris operation) and shall allow for
      indoor/outdoor applications. The outdoor enclosure shall have a front-hinged lid to
      provide easy access to the removable camera sled and shall have two adjustable
      (PG13.5) glands on the bottom of the enclosure for easy installation of the power
      and video cables. Allowable (factory installed) options shall include heater-
      defroster, blower, and sun shroud.
   b. The outdoor enclosure shall meet or exceed the following design and performance
      specifications.

3. Environmental Specifications
   a. Environment: Indoor/outdoor
   b. Temperature: -10°F to 120°F (-23°C to 49°C)

4. Physical Specifications
   a. Construction: Extruded and die-cast aluminum
   b. Finish: Gray polyester powder coat
O. FT8201 1/FR82011 ETHERNET MEDIA CONVERTER

1. General
   a. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer’s system.
   b. All systems and components shall have been thoroughly tested and proven in actual use.
   c. All systems and components shall be provided with the availability of a toll-free (U.S. and Canada), 24-hour technical assistance program (TAP) from the manufacturer. The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.
   d. All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and nonwarranty items.

2. Ethernet Media Converter
   a. The Ethernet media converter shall provide one 10BASE-T/100BASE-TX port and one 100BASE-FX fiber port. The Ethernet media converter shall support wavelength division multiplexing (WDM), which allows bidirectional data to be transported in a single fiber. The Ethernet media converter shall be designed for point-to-point applications.
   b. The Ethernet media converter shall provide user-selectable 10BASE-T/100BASE-TX networking functions: autonegotiation between 10 Mbps and 100 Mbps data rates and between full-duplex and half-duplex modes; 10 Mbps or 100 Mbps data rate, selectable; full-duplex or half-duplex mode, selectable; and the enabling/disabling of flow control. The Ethernet media converter shall support auto MDI/MDIX (medium dependent interface/medium dependent interface crossover) operation. The Ethernet media converter shall support link-down detection, which propagates a link-down status among all 10BASE-T/100BASE-TX and 100BASE-FX ports connected in the network when a 10BASE-T/100BASE-TX or 100BASE-FX link goes down.
   c. The Ethernet media converter shall have a stand-alone and rack-mountable modular design. The Ethernet media converter shall be supplied in a universal mechanical package that allows each unit to be used as a desktop or wall mount (with supplied mounting accessories) or in a rack enclosure in addition to other modules.
   d. The Ethernet media converter shall meet or exceed the following design and performance specifications.

3. Performance Specifications
   a. Switch Type: Unmanaged Layer 2
   b. Switch Method: Store and forward
   c. Data Rate: 10/100 Mbps
   d. Compliance: IEEE 802.3, 802.3u, 802.3x
   e. Interface: Auto MDI/MDI-X
   f. Operating Mode: Half-duplex or full-duplex
g. Address Table Size 1,024 MAC address entries with automatic learning and aging
h. Quality of Service IEEE 802.1p priority, tag-based, 4 queues per port, weighted fair queuing scheduling
i. Maximum Frame Size Untagged Ethernet frames up to 1,518 bytes
   Tagged Ethernet frames up to 1,522 bytes

4. General Specifications
   a. Operating Temperature -40°F to 167°F (-40° to 75°C)
   b. Input Power Requirements 12 VDC or 24 VAC, 0.50 A
c. LED Indicators
   100BASE-FX Port Status (link/activity, FEFI)
   Optic Fault (optic signal/laser status)
   10BASE-T/100BASE-TX Port Status
   (2 LEDs: link/activity and speed, duplex/collision and speed)
d. Dimensions 8.75” D x 1.08” W x 4.81” H
   (22.23 x 2.74 x 12.22 cm)
e. Unit Weight 1.6 lb (0.73 kg) (approximate)

5. Mechanical Specifications
   a. Connectors
      1) Rack Power/Alarm 1, 4-pin connector
      2) Stand-Alone Power 1, 2-pin connector, screw terminal
      3) Electrical 1, RJ-45, 10BASE-T/100BASE-TX
      4) Fiber Optic 1, single-fiber ST or SC

6. Optical Specifications
   a. Number of Fibers 1
   b. Wavelength (Transmit/Receive)
      1) Multimode Fiber 1310/850 nm (fiber port A), 850/1310 nm (fiber port B)
      2) Single-Mode Fiber 1310/1550 nm (fiber port A), 1550/1310 nm (fiber port B)
c. Power Budget
      1) Multimode 26 dB (subtract 3 dB for 50/125 µm fiber)
         (62.5/125 µm)
      2) Single-Mode 28 dB
         (9/125 µm)
d. Maximum Transmission Distance
      1) Multimode Fiber 2 km (1.2 mi)Note: Maximum transmission distance is limited by fiber bandwidth.
2) Single-Mode Fiber  46 km (28.6 mi)\textbf{Note:} Maximum transmission distance is based on attenuation of 0.5 dB/km plus a 5 dB buffer for connector and splice losses.

7. Certifications

a. ISO 9001 certification
b. CE, Class A
c. UL Listed
d. UL Listed to Canadian safety standards
e. FCC, Class A
f. C-Tick
g. Complies with FDA requirements for Class 1 laser products
h. Designed to meet NEMA TS 2 and Caltrans traffic signal control equipment standards for ambient operating temperature, mechanical shock and vibration, humidity with condensation, high-line/low-line voltage conditions, and transient voltage protection (certification pending)

2.3 SYSTEM COMPONENTS

A. The following equipment will be provided. Refer to drawings for quantities, unless noted otherwise.

B. All components required for a complete and fully operational system shall be provided. Coordinate all system components with a Combustion Services.

2.4 UNINTERRUPTABLE POWER SUPPLY

A. One uninterruptible power supply (UPS) shall give provided to sustain the operation on the IP video management system in the main command center. The UPS shall be provided to sustain the operation of all equipment located in the main command center for a period of twenty (20) minutes.

B. The UPS shall provide continuous, no-break power during complete or momentary loss of supply power.

C. In the normal operating mode the UPS shall condition line power protecting against environmental conditions, power surge, power sag, under-voltage, over-voltage, line noise, frequency (variation of the waveform), transients and harmonic distortion.

D. An external bypass switch shall be provided to allow the UPS to be removed from the incoming power line for service.

E. The uninterruptible power supply (UPS) shall be manufactured by American Power Conversion (APC)
2.5 WIRING

A. Wiring to the cameras from the digital recorders shall be West Penn A2815.

B. Wiring shall be plenum rated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All material and/or equipment necessary for the proper operation of the system, even though not specifically mentioned in the contract documents, shall be deemed part of this contract.

B. All equipment shall be installed and connected in strict accord with the manufacturers' recommended instructions.

C. The Contractor shall have equipment installed on the AC voltage supply taking care to arrest damaging transients and spikes, which can cause damage to the components of the system.

D. The specified equipment shall be supplied, installed, adjusted, tested and guaranteed by a factory authorized communications contractor for the products furnished. The vendor is responsible for verifying the completeness of the parts list and the suitability of the equipment to meet the intended purpose of the specifications and drawings.

E. Securely mount all components at locations and heights as shown on drawings.

F. Adequately support cable. Use connectors specifically designed for the type of cable being used. Verify all wiring/cabling types with system supplier prior to purchase.

G. Install all equipment power wiring and grounding to conform to NEC requirements and applicable local codes.

3.2 GROUNDING

A. Provide equipment grounding connections as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible ground loops, common mode returns, and other impairments. Provide 5-ohm ground at main console location. Measure, record, and report ground resistance.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
B. Before final acceptance, conduct an operating test of all cameras and system components. The system shall be demonstrated to operate in accord with requirements of these specifications. The test shall be performed in the presence of an authorized representative of the Owner. Contractor shall furnish all equipment and personnel required for the tests.

C. Should such a demonstration of performance show that the Contractor has not properly balanced the system and that picture degradation is present or that performance is not as specified, make all necessary changes or adjustments and a second demonstration will be arranged.

D. Testing: Upon completion of pretesting, notify the Owner a minimum of 10 days in advance of acceptance test performance. Schedule and conduct tests in his presence. Provide a written record of tests results.

E. Operational Test: Perform an operational system test to verify conformance of system to these Specifications.

F. Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified.

G. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards. Provide a written record of all retest results.

H. Adjustments - System shall be adjusted and equalized for optimum performance. Record all adjustments, which shall be included with the as-built drawings.

3.4 TRAINING AND START-UP

A. A Trained technician shall be provided to train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of three hours training.

B. Schedule training with Owner, with at least seven days advance notice.

3.5 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

3.6 WARRANTY

A. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Owner/Engineer, or the first day of beneficial use by the Owner. A maintenance contract offering continuing factory authorized service of this system shall be made available if requested by the Owner.
3.7 SYSTEM TRAINING

A. Proposal shall include 24 hours of system training on-site by a representative of the SMS manufacturer. Training shall take place before the system is operational as described in the project schedule. A detailed description of the training material shall be included in the submittal package. All training courses shall enable the attendees to be capable of all normal system operations within their respective positions.

B. If an alternate Andover SMS Contractor is selected other than the school districts existing Andover representative, the alternate SMS system contractor shall provide an additional 48 hours of onsite training. This is required because of dissimilar operating systems and programming requirements. This additional training is equal to the training the owner has received on the existing Andover security system.

C. System Administrators shall receive a course detailing the system functions and operations. Course shall offer configuration training on all aspects of the system including data import-export, reports, card holder management, system workstations, peripherals and field hardware.

END OF SECTION 28 2300